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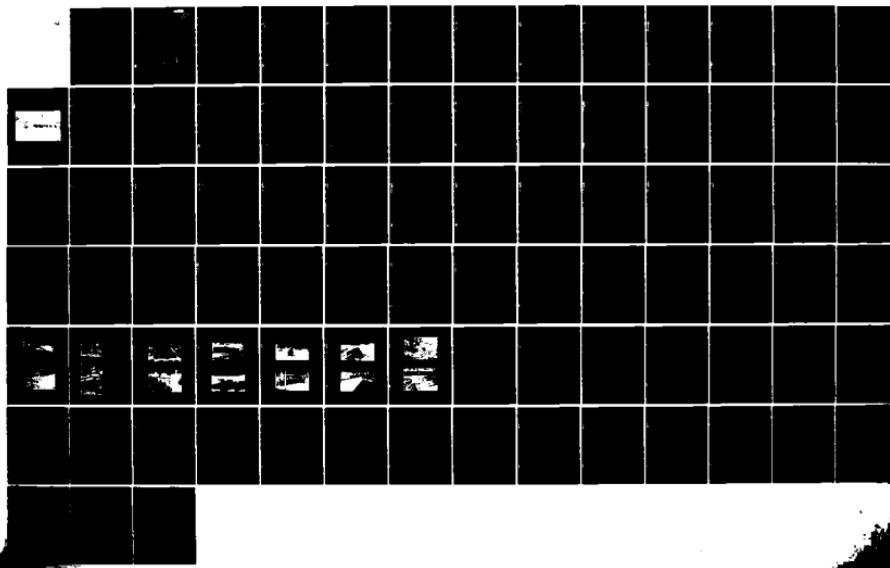
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GREENVILLE DAM (CT 06. (U) CORPS OF ENGINEERS WALTHAM  
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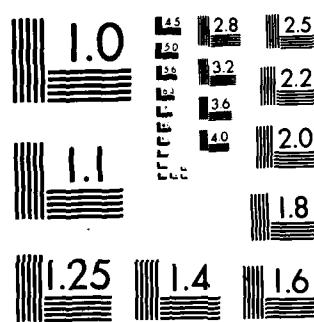
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AD-A143 431

THAMES RIVER BASIN  
NORWICH, CONNECTICUT

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GREENVILLE DAM  
CT. 00206

PHASE 1 INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM



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DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION, CORPS OF ENGINEERS  
WALTHAM, MASS.

OCTOBER, 1980

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) DAMS, INSPECTION, DAM SAFETY, Thames River Basin Norwich, Conn. Greenville Dam		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Greenville Dam is a long stone filled timber crib spillway structure with two earth embankments with vertical stone masonry facing forming the spillway abutments. The total length of the dam is 664 ft. including the 400 ft. timber crib spillway. The dam was judged to be in FAIR condition. The dam is classified as INTERMEDIATE in size and a HIGH hazard in accordance with the recommended guidelines established by the Corps of Engineers.		



DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION. CORPS OF ENGINEERS  
424 TRAPELO ROAD  
WALTHAM, MASSACHUSETTS 02254

REPLY TO  
ATTENTION OF:

NEDED

MAR 06 1961

Honorable William A. O'Neill  
Governor of the State of Connecticut  
State Capitol  
Hartford, Connecticut 06115

Dear Governor O'Neill:

Inclosed is a copy of the Greenville Dam (CT-00206) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, City of Norwich, Norwich, CT 06360.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely,

C. E. EDGAR, III  
Colonel, Corps of Engineers  
Division Engineer

Incl  
As stated

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GREENVILLE DAM

CT 00206

THAMES RIVER BASIN  
NORWICH, CONNECTICUT

PHASE 1 INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE 1 INSPECTION REPORT

IDENTIFICATION NO:

CT 00206

NAME OF DAM:

Greenville Dam

COUNTY AND STATE:

New London County,  
Connecticut

STREAM:

Shetucket River

DATE OF INSPECTION:

7 April, 1980

Brief Assessment

The Greenville Dam is a long stone-filled timber crib spillway structure with two earth embankments with vertical stone masonry facing forming the spillway abutments. The total length of the dam is 664 feet including the 400 feet timber crib spillway. The outlet works for the dam is a series of 6-10 ft. W x 10 ft. H gates leading to a downstream canal used for generating power at a downstream facility. This dam has a maximum height of 29.0 feet and was originally built in the year 1882.

The dam was judged to be in FAIR condition. However, because the river stage at the time of the visual inspection was high, the assessment of the dam is based only on those visible portions that could be readily inspected. Those components were the abutment embankments and the outlet structure. The spillway could not be evaluated. Several items require attention to insure the long term performance of the dam. They include: seepage at the left embankment, erosion at the toe of the left embankment, brush growth of the upstream face of the right embankment. Construction work at the left embankment has resulted in the temporary creation of a low area in that embankment crest.

The dam is classified as INTERMEDIATE in size and a HIGH hazard in accordance with the recommended guidelines established by the Corps of Engineers. The routed Test Flood outflow for this dam is equal to the Probable Maximum Flood (PMF) or approximately 140,000 CFS and would overtop the dam by 6.2 feet. The maximum spillway discharge of 84,480 CFS represents 60 percent of the test flood outflow. Because there are several flood control reservoirs located within the drainage basin of the dam that are owned and operated by the U.S. Army Corps of Engineers, it is very likely that a detailed analysis will indicate that the approximate inflow of 141,500 CFS and the overtopping potential used in this report will need to be modified to include their impact.

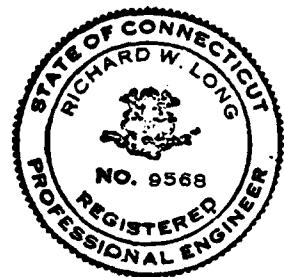
It is recommended that the Owner engage the services of a registered engineer experienced in the design of dams to accomplish the following:

perform more detailed hydraulic and hydrologic studies to determine the discharge capacity and the overtopping potential of this dam taking into account the impact of upstream flood control structures in attenuating the flood, remove the vegetation from the right embankment, repair the road cut in the left embankment, and monitor the wet zones at the left embankment area.

Additional recommendations and remedial measures are detailed in Section 7 and should be implemented by the Owner within one year after receipt of this Phase 1 Inspection Report.

CE Maguire, Inc.

By: Richard W. Long  
Richard W. Long, P.E.  
Vice President



This Phase I Inspection Report on Greenville Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Armand M. Mahtesian

ARAMAST MAHTESIAN, MEMBER  
Geotechnical Engineering Branch  
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER  
Design Branch  
Engineering Division

Richard J. DiBuono

RICHARD DIBUONO, CHAIRMAN  
Water Control Branch  
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar  
JOE B. FRYAR  
Chief, Engineering Division

## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase 1 Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, DC 20314. The purpose of a Phase 1 Investigation is to identify expeditiously those dams which may pose hazards to human life or to property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain condition which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase 1 inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonable possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

The Phase 1 Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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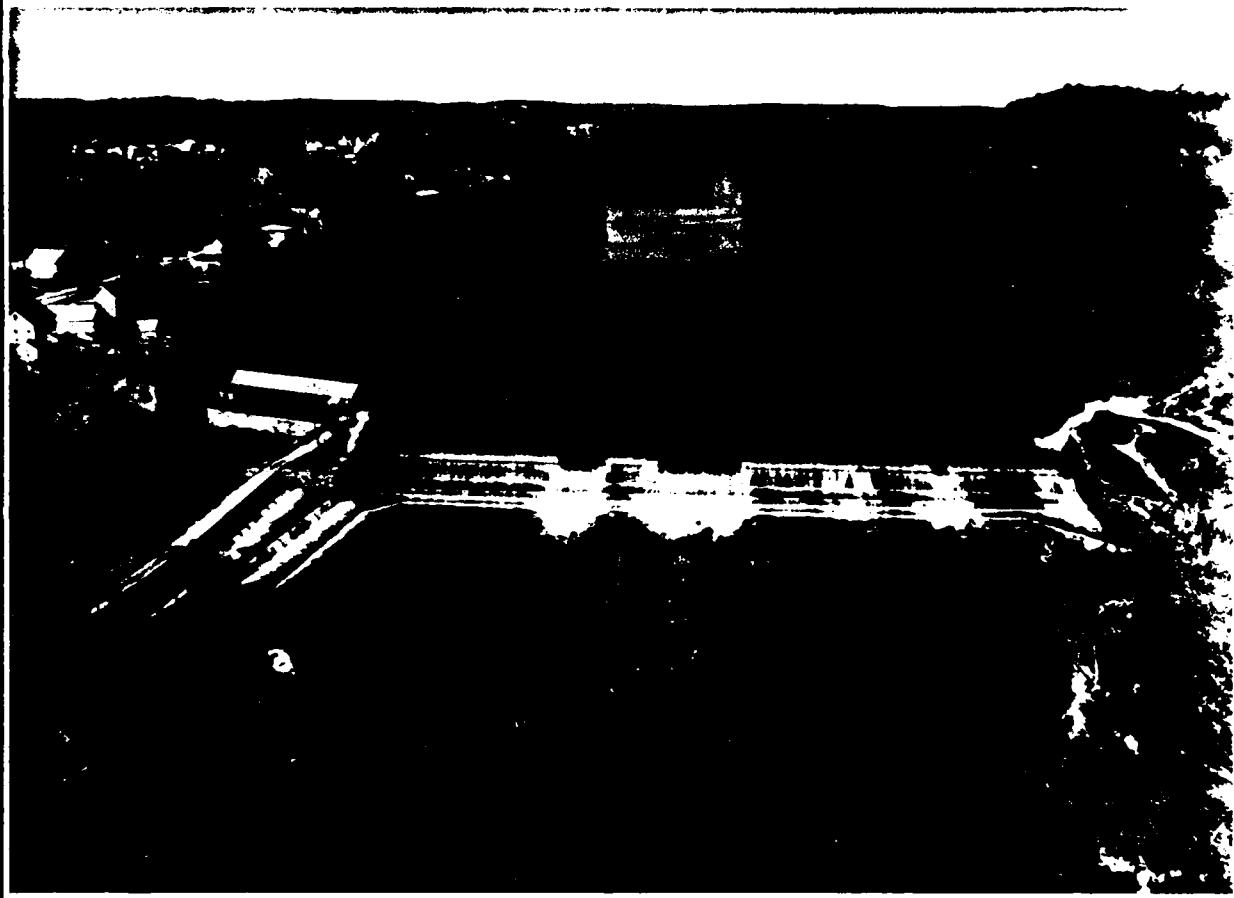
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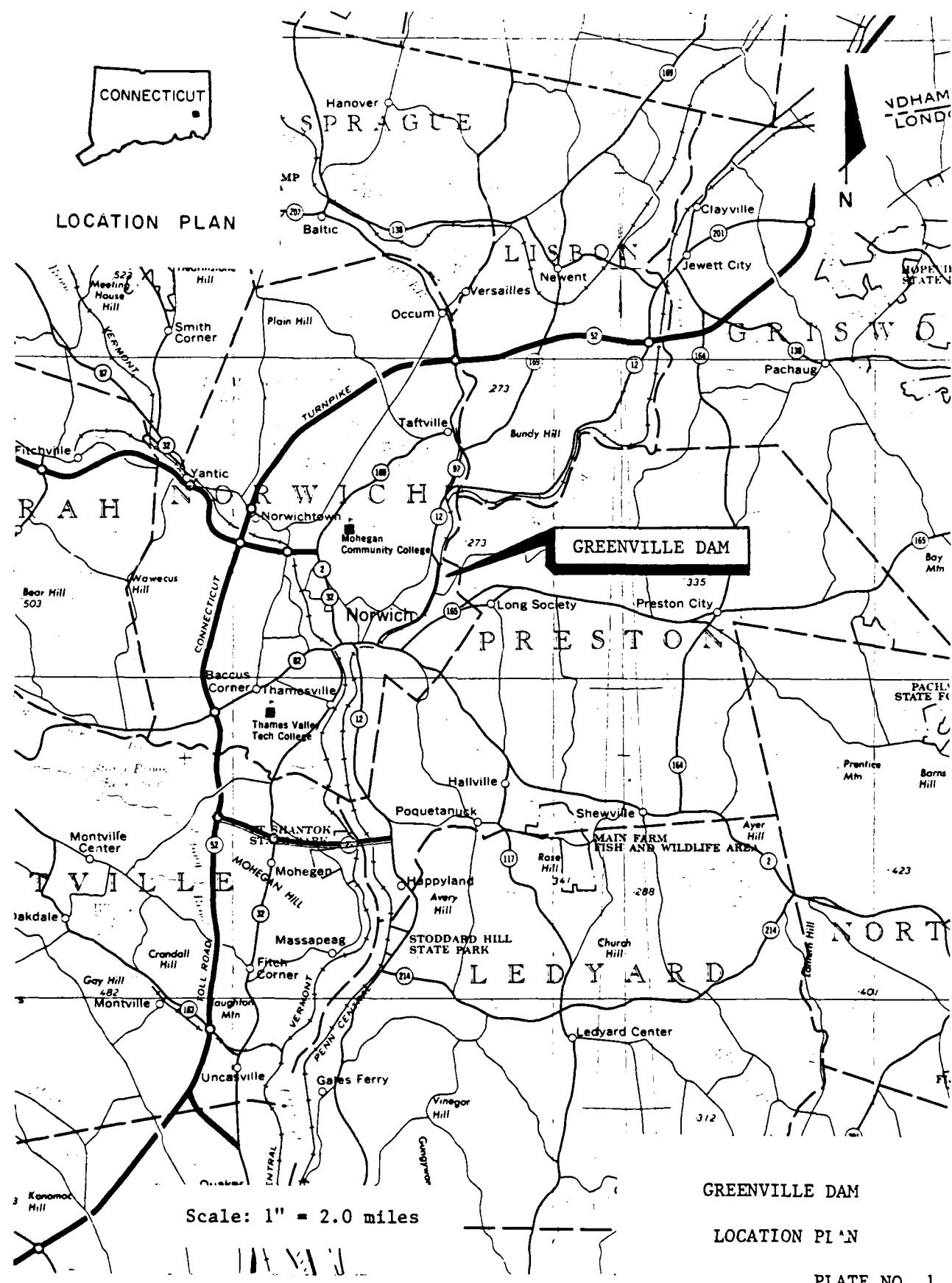
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OVERVIEW PHOTO - Greenville Dam



### LOCATION PLAN



GREENVILLE DAM

LOCATION PLAN

PLATE NO. 1

Scale: 1" = 2.0 miles

NATIONAL DAM INSPECTION PROGRAM

PHASE 1 - INSPECTION REPORT

GREENVILLE DAM

SECTION 1

PROJECT INFORMATION

1.1 General

- a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army through the Corps of Engineers to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. CE Maguire, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed was issued to CE Maguire, Inc., under a letter from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-80-C-0013 has been assigned by the Corps of Engineers for this work.
- b. Purpose of Inspection.
  1. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
  2. Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
  3. To update, verify and complete the National Inventory of Dams.

1.2 Description of the Project

- a. Location. Greenville Dam is located in the city of Norwich, New London County, Connecticut. Coordinates of the dam are approximately 41° 32.3' N Latitude and 72° 03.1' W Longitude. The dam impounds water in the Shetucket River which drains 1,261 square miles of rolling terrain. The dam is located about 11,000 feet upstream from the confluence of Shetucket River and the Thames River. The axis of the dam is oriented in a east-west alignment with the river impoundment to the north of the dam.

b. Description of the Dam and Appurtenances. The Greenville Dam is a stone filled timber crib spillway structure with stone faced earth embankments at each abutment. The total length of the dam is 664 feet. Earth embankments at each end of the spillway structure comprise 264 feet of the total length. The spillway length of 400 feet extends the entire width of the Shetucket River. The left embankment has a top width of 42 feet and the top width of the right embankment is 26 feet. The right embankment also contains the outlet works for the dam. The outlet works is a stone masonry structure with 6 arch openings of 10 foot width and 10 foot height on the downstream face and rectangular openings of the same size on the upstream face. The control gates for these openings are constructed of timber and are in two panels, similar to a double hung window. They operate by sliding vertically and are raised by rack and pinion equipment. Three of the gates have been fitted with electrical hoist mechanisms. A timber gatehouse encloses the operating facilities. (See Photo C-10 in Appendix C). Gates are in operable condition.

The spillway is a timber crib work with stone-fill. See the drawings in Appendix B-3 for details. The length of the spillway weir is 400 feet and the width at the crest is 7 feet. The dam has a provision for installation of 1.3 feet high flashboards along the spillway crest. This could not be verified during the visual inspection due to the large overflow at the time. Discharge from the spillway continues in the Shetucket River. The discharges from the outlet works flow into a downstream canal which parallels the Shetucket River. The water surface in the outlet canal was about 12 feet above the river stage at the time of the inspection. The water in the outlet canal is utilized for hydroelectric power generation at a facility further downstream. This outlet canal has a side channel spillway as shown on a sketch in Appendix C and Photo C-12 to limit the maximum discharge entering the powerhouse.

c. Size Classification. The Greenville Dam has an impoundment capacity at the top of the dam (elev. 36.3 feet NGVD) equal to 3360 Ac-Ft and a maximum height of 29 feet. In accordance with guidelines established by the Corps of Engineers, this dam is classified as an INTERMEDIATE size structure based on its impoundment capacity.

d. Hazard Classification. This dam is classified as a HIGH hazard potential structure because its failure could result in loss of more than a few lives, damage and inundation of 20-25 dwellings and commercial properties in the City of Norwich, damage to the support structures for the 8th Street, Main St. (Rt. 2), Rt. 12, Water Street and Amtrack Railroad bridges and temporary disruption to traffic and utility services located within or along those roadways. Loss of the dam will also prevent the generation of electricity by the City of Norwich.

It is estimated that the failure discharge of 131,720 CFS will travel downstream through the Shetucket River with high velocities. Depths of flow downstream from the dam before and after the dam failure are 18.0 and 21.0 feet for respective discharges of 84,480 and 131,720 CFS. Increased depth in the inspected areas due to failure of the dam will be approximately 3.0 feet and there will be 4-7 feet of water in the impacted dwellings and commercial properties. The failure will cause flooding conditions downstream and the velocity of flow will carry debris and cause erosion.

- e. Ownership. The dam is presently owned by the City of Norwich, Connecticut.
- f. Operator. The dam is operated by the City of Norwich, Department of Public Utilities, 34 Shetucket Street, Norwich, Connecticut, 06360. Personnel are under the direction of Mr. C.F. Rossoll, Chief Electrical Engineer (1-203-887-2555).
- g. Purpose of Dam. To provide water for hydroelectric power-generation for the Department of Public Utilities, City of Norwich, Connecticut.
- h. Design and Construction History. The Greenville Dam was built in 1882. Records indicate that replacement of the timber planking started about 1947. Damage occurred to the planking during the intense storms of 1955 and additional repair work was apparently performed. Other recorded repair work has been performed in 1965, 1969, 1978 and at the present time, April 1980. Records indicate that all of the foregoing repairs were to the timber spillway only.
- i. Normal Operational Procedure. The outlet gates are adjusted to maintain water level in the outlet canal to avoid spillover in the side channel spillway located on this canal. Normally, the water level can be maintained by leaving the gates wide open. When the river level is high, the gates are partially closed to cut back the flow. Chart recorders register the water level in the river upstream of the spillway crest and in the outlet channel. A daily record of the level is maintained. Spillover in the canal side channel spillway structure is reduced somewhat by leakage to the river by canal water along the length of the channel. This intake canal, 2500 feet long, leads to a hydroelectric generation facility with 2200 KW installed capacity and an average net-head of 14.0 feet. The plant is shut off during the high floods when sufficient differential head (difference between upstream and tailwater elevation) is not available and this is done by closing the upstream gates.

### 1.3 Pertinent Data

a. Drainage Area. The drainage basin for the Greenville Dam is approximately 60 miles long, 30 miles wide and equal to 1,261 square miles in area. The basin extends from the Spencer State Forest near Worcester, Massachusetts in the north, to Norwich in the South; and from the Connecticut-Rhode Island State Line in the east to Manchester in the West. The topography is generally flat to rolling terrain with elevations ranging from a high of 1,074 feet at Spencer State Forest to 20.3 feet at the spillway crest. In addition, the large storage areas and flood control structures within the watershed will tend to dampen and delay the peak of the surface runoff. There are six flood control structures located upstream within the watershed with the following pertinent features:

<u>Reservoir</u>	<u>Controlling D.A.</u>	<u>Remarks</u>
Mansfield Hollow	159.0	For Greater
Buffumville	26.5	Details See
Hodge Village	31.0	Appendix F
East Brimfield	67.5	
Westville	32.0	
West-Thompson	74.0	

b. Discharge at the Damsite. Recorded levels of the Shetucket River are continuously obtained at the damsite by the City of Norwich. There is no other discharge data available for this dam. Listed below is calculated discharge data for the spillway and outlet works:

#### 1. Outlet Works:

Conduit size	6-10' x 10' rectangular Conduit invert elevation 9.30 feet (Total area = 600 square feet)
i. Discharge capacity	7,350 CFS @ spillway crest elevation 20.3
ii. Discharge capacity	14,070 CFS @ top of dam elevation 36.3 feet
iii. Discharge capacity	14,650 CFS @ test flood elevation 38.15 feet
2. Maximum known flood at damsite	September, 1938 - 75,000 CFS

3.	Ungated spillway capacity at top of dam	84,480 CFS
4.	Ungated spillway capacity at test flood elevation	140,000 CFS
5.	Gated spillway capacity at normal pool elevation	N/A
6.	Gate spillway capacity at test flood elevation	N/A
7.	Total spillway capacity at test flood elevation	140,000 CFS
8.	Total Project discharge at top of dam	98,550 CFS
9.	Total Project discharge at test flood elevation	154,650 CFS

c. Elevation (Feet NGVD)

1.	Streambed	7.3
2.	Bottom of Cut-off	Unknown
3.	Maximum tailwater	Unknown
4.	Recreation Pool	N/A
5.	Full flood control pool	N/A
6.	Spillway crest	20.3*
7.	Design discharge (originial design)	Unknown
8.	Top of dam	36.30
9.	Test Flood design surcharge	42.50

d. Reservoir (Length in feet)

1.	Normal pool	6,000 (estimated)
2.	Flood control pool	N/A
3.	Spillway crest pool	6,000 (estimated)
4.	Top of dam	6,000 (estimated)

\*Spillway crest - elevation adopted in Master Manual of Reservoir - Thames River Basin = 21.40.

5.	Test flood pool	6,000 (estimated)
<b>e. <u>Storage (acre-feet)</u></b>		
1.	Normal pool	800
2.	Flood control pool	N/A
3.	Spillway crest pool	800
4.	Top of dam	3,360
5.	Test flood pool	4,200
<b>f. <u>Reservoir Surface (acres)</u></b>		
1.	Normal pool	160
2.	Flood control pool	N/A
3.	Spillway crest pool	160
4.	Top of dam	160
5.	Test flood pool	160
<b>g. <u>Dam</u></b>		
1.	Type	Wooden crib stone filled dam.
2.	Length	664 feet
3.	Height	29 feet
4.	Top width	Varies
5.	Side slopes	Varies
6.	Zoning	N/A
7.	Impervious Core	Unknown, crest wooden crib stone & earth filled
8.	Cutoff	Unknown
9.	Grout curtain	Unknown
10.	Other	---

h. <u>Diversion Channel</u>	Intake flume to the powerhouse for hydro-generation.
1. Type	Rectangular channel
2. Length	2,500 feet
3. U/S Control	6 - 10' x 10' gates with invert 9.3 elevation
4. Gates	Yes
5. There is a side channel spillway on this intake canal (see Photo C-12) Refer to paragraph 1.1i for more details.	
i. <u>Spillway (at dam)</u>	
1. Type	Uncontrolled overflow (granite cap) weir, cascade downstream face.
2. Length of Weir	400 feet
3. Crest elevation with no flashboards Crest elevation with flashboards (no flashboards were observed at time of inspection)	20.3 feet 21.3 feet
4. Gates	None
5. U/S Channel	Natural river bed Shetucket River
6. D/S Channel	Natural river bed Shetucket River
j. <u>Regulating Outlets</u>	
Refer to paragraph 1.2b "Description of Dam and Appurtenances" for description of outlet works.	
1. Invert	9.3 feet

2. Size	6 - 10 feet x 10 feet
3. Description	6-slide type wooden gates-stone masonry structure
4. Control Mechanism	3 electrically assisted or manually operated wooden gates plus 3 manually operated gates.
5. Other	---

## SECTION 2

### ENGINEERING DATA

#### 2.1 Design Data

The following documents which contain the principal information regarding this dam were reviewed in the preparation of this report.

1. Plans entitled: "Norwich Water Power Company's Dam". Three (3) sheets prepared by Chandler and Palmer, Engineers of Norwich, Connecticut, dated December 1915.

#### 2.2 Construction Data

Correspondence relating to repair work dating from 1947 was available for review.

#### 2.3 Operation Data

Water levels are recorded and maintained by the City of Norwich Department of Public Utilities.

#### 2.4 Evaluation of Data

- a. Availability. The information noted above for this facility is available in the files of the:

Attn: State of Connecticut  
Department of Environmental Protection  
State Office Building  
165 Capitol Avenue  
Hartford, Connecticut  
Mr. Victor J. Galgowski,  
Dam Safety Engineer

and

Attn: City of Norwich,  
Department of Public Utilities,  
34 Shetucket Street  
Norwich, Connecticut 06360  
Mr. C.F. Rossoll  
Chief Electrical Engineer

- b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assured from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance and sound engineering judgement.

- c. Validity. The validity of the limited data must be verified.

SECTION 3  
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase 1 inspection of Greenville Dam was performed on 17 April, 1980 by representatives of CE Maguire, Inc., and Geotechnical Engineers, Inc. A visual checklist and photographic record of that inspection has been included in Appendix A and C, respectively, of this report. At the time of the inspection approximately 1.5 feet of water was flowing over the crest of the spillway. Since this flow entirely covered the spillway structure making it unobservable, the condition of the spillway has not been rated. The overall rating of embankments and appurtenant structures is judged to be FAIR. This evaluation is based on the visual inspection, history, existing drawings and general appearance.
- b. Dam.
  1. Spillway. Existing drawings, of the dam, indicates the main spillway section of the dam is constructed of timber cribbing filled with hand packed stones. The spillway is approximately 400 ft-long. Currently, repair work is taking place at the dam site as shown on Photo C-3. Several of the sheet piles can be seen protruding from the water surface. The repair to the spillway is reportedly replacement of deteriorated timbers of the crib and surface timbers and backfilling along the upstream face with gravel.
  2. Left Embankment. The left masonry block wall of the dam is shown in Photos C-1 and C-5. A concrete training wall has been built downstream from the masonry wall to divert water away from the toe of the downstream masonry wall and adjacent earth embankment (Photos C-5 and C-7). A roadway has been excavated adjacent to the left abutment as indicated in Photos C-1 and C-4. This roadway construction has created a minor depression in the crest profile of the dam. The length and depth of this depression could not be measured and inspected due to overflow conditions. A small seep was noted near the downstream toe of the embankment approximately 30 ft. to the left of the end of the masonry training wall. This seepage zone can be observed in Photo C-13. The Owner reports that repair work is presently taking place at the toe of the left embankment where a small tributary flows into the

Shetucket River just downstream from the spillway (See Photo C-14). This repair includes the installation of a pipe and headwall to carry the tributary flows more readily into the main river.

c. Appurtenant Structures and Right Embankment.

1. Outlet Works and Right Embankment. The outlet works and right embankment form a continuous structure at the right end of the spillway. This complex is shown in the overview photo. The downstream side end of the outlet works structure is shown in Photo C-10 and the intake side in Photo C-2. The stone masonry forming this structure appeared to be in fair condition with missing mortar in many areas and trees and vines growing out of the base of the wall. The right abutment of this structure is shown in Photo C-6.
2. Gatehouse and Gate Controls. The gatehouse is a timber superstructure on the stone masonry portion of the embankment. This structure is shown in Photos C-2, C-10, and C-12. The general condition of the superstructure was to be judged fair. The gates appeared to be well maintained and in operating condition although an operational check was not conducted. Three of the six gates can be electrically operated, the remaining gates are manually operated.
3. Canal Outlet Channel Spillway. This structure is shown in Photo C-12. The structure is of concrete and judged to be good condition.
4. Canal Intake Channel. The intake channel is shown in Photo C-9. The channel runs parallel to the Shetucket River and is connected with the river immediately upstream from the gatehouse (Photo C-2). The location of the intake channel is visible in the overview photo as a break in the trees upstream from the gatehouse. There are many overhanging trees and branches.
5. Canal Outlet Channel. The outlet channel which feeds the various users of water downstream from the dam is shown in Photo C-11. The outlet channel spillway is shown in Photo C-11 on the left hand side. Masonry walls form the left side of the channel while natural earth embankment forms the right side. The sidewalls of the canal appear to be in good horizontal and vertical alignment above the water line at the time of the inspection with no apparent sloughing. The length of this channel is 2500 feet.

- d. Reservoir Area. No specific detrimental features were observed in the reservoir during the visual inspection. The slopes of the shoreline are overgrown with trees and brush. Because of the dense vegetation, periodic observations should be made to check for debris such as tree trunks and limbs which could become entrapped on the spillway crest or outlet gates.
- e. Downstream Channel. The downstream channel is the natural riverbed of the Shetucket River. No significant obstructions existed in the channel at the time of inspection (See Photo C-8).

### 3.2 Evaluation

A thorough Phase 1 evaluation of the spillway portion of the dam could not be performed because water flow over the crest prevented access to the downstream portion of the dam.

Based on examination of the embankments and appurtenant structures, these observable features were judged to be in fair condition. The following deficiencies could adversely affect the future performance of the dam:

1. Seepage exiting at the downstream toe of the embankment section at the left side of the dam could affect the long-term integrity.
2. The road which has been cut into the left abutment may lead to future erosion and a possible breach of the embankment during periods of high runoff.
3. Trees and vines existing at the toe of the upstream face of the outlet works structure could lead to displacement of the masonry block if allowed to continue to grow.
4. An inspection and evaluation of the spillway should be made during a low flow period.
5. The minor depression on the spillway crest noted at the left embankment does not significantly increase the volume of overtopping but should be corrected under normal maintenance.

## SECTION 4

### OPERATIONAL AND MAINTENANCE PROCEDURES

#### 4.1 Operational Procedures

- a. General. The Greenville Dam is regulated by the personnel of the City of Norwich, located at Department of Public Utilities City of Norwich, South Golden Street.

The gates are normally maintained in the open position. During high flows, the gate openings are adjusted to avoid water spilling over the side channel spillway due to reported seepage and stability problems on this structure. During flood flows, the gates are completely closed and the power plant shut-off because the reduced head on the turbine units is too small for their efficient operation. Daily records are maintained of water level in the outlet canal and river above the dam.

- b. Description of Any Warning System in Effect. Emergency procedures are posted at the power station which is located on the outlet canal several hundred feet downstream from the dam. A copy of these procedures is included in Appendix B-1.

#### 4.2 Maintenance Procedures

- a. General. Trees and brush growing on the embankments are generally trimmed side cut on an annual basis. Maintenance was in progress on a portion of the spillway as can be seen in the Photo C-3. Except for some vegetation growing from the masonry of the embankment the facilities appeared to be well maintained.
- b. Operating Facilities. All of the gates receive as needed maintenance to keep them operable. At the time of the inspection, 3 of the gates had recently been overhauled. One gate had been replaced in its entirety, two others, partially replaced.

#### 4.3 Evaluation

It is not possible to comment on the effectiveness of maintenance of the timber crib spillway at this time. The outlet gates, right embankment and outlet channel spillway appeared to be well maintained. These facilities are observed by City of Norwich operating personnel on a daily basis. The left embankment area is maintained to the extent of cutting brush and trees. Erosion areas require further maintenance.

## SECTION 5

### EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General. The Greenville Dam is located on the Shetucket River, in eastern Connecticut, approximately 2.1 miles northeast of the confluence of the Thames and Shetucket Rivers. The dam was constructed around 1882 and is presently used to produce electrical power by means of a low head hydro facility located downstream. At the spillway crest elevation of 20.3 feet, the capacity of the outlet structure is 7,348 CFS. It would require one-half hour to lower the reservoir level one foot. To drain the 800 Ac-Ft of available storage below the spillway crest, it will require 3 hours using the existing outlet.

The dam has a spillway length of 400 feet and a surcharge height of 16 feet. The total length of the dam is 664 feet. The reservoir has a storage capacity at the spillway crest level of 800 Ac-Ft and can accommodate .012 inches of runoff from the watershed. Each foot of depth in the reservoir above the spillway level can accommodate 160 Ac-Ft of water equivalent to 0.002 inches of runoff.

At the spillway crest elevation of 20.3 feet the capacity of the outlet structure is 7,348 CFS. It would require one-half hour to lower the reservoir level one foot. To drain the 800 Ac-Ft of available storage below the spillway crest, it will require 3 hours using the existing outlet.

5.2 Design Data. Limited design data is available for this watershed and dam. To supplement the existing design information U.S.G.S. Topographic Maps (scale 1" = 2,000 ft.) were utilized to develop hydrologic parameters such as drainage area, reservoir surface areas, basin slopes, time of concentration and other runoff characteristics. Elevation/storage relationships for the reservoir were estimated. Surcharge storage was computed assuming the surface area remained constant above the spillway crest. Some of the pertinent hydraulic data was obtained and/or confirmed by actual field measurements at the time of the visual inspection. Test flood values and dam failure profiles were developed in accordance with the Corps of Engineers guidelines. Final values used in this report are quite approximate and are no substitute for detailed analysis.

5.3 Experience Data. Historical data for recorded discharges and water surface levels as available for this dam are reproduced below:

<u>Date</u>	<u>Discharge in CFS</u>	<u>Stage</u>
1936, March	51,500 (37,200)*	32.0 (30.4)*
1938, September	75,000 (47,200)*	35.0 (32.0)*
1955, August	65,000 (35,200)*	35.0 (30.0)*
Standard Project Flood	129,000 (94,000)*	42.0 (38.2)*

\*Modified by upstream reservoirs in the watershed.

5.4 Test Flood Analysis. Recommended guidelines for the Safety Inspection of Dams by the Corps of Engineers were used for selection of the "Test Flood". This dam is classified under those guidelines as a HIGH hazard and INTERMEDIATE in size. Guidelines indicate that the full PMF be used as the test flood for such classification. The watershed has a total drainage area of 1,261 square miles of which (10%) is swampy or covered by natural storages. This drainage area is sparsely populated, largely wooded, is hilly with rolling terrain, with basin slopes averaging 0.004 feet per feet which can be considered as flat. A "test flood" equal to the full PMF was calculated to be 112 CSM, equal to 141,500 CFS and was adopted for this analysis. The routed outflow discharge for the test flood inflow was 140,000 CFS assuming the outlets to the hydro-generating intake canal are closed. The discharge through these outlets to the hydro-generating facilities is 14,650 CFS at the Test Flood elevation thus making total project discharge at the Test Flood elevation 154,650 CFS. Total project discharge at top of dam is 98,550 CFS with 14,070 CFS passing the intake canal outlet structure. The spillway and outlet rating curves are illustrated in Appendix D. Flood routings were performed assuming a full reservoir (at spillway crest elevation.)

In the Master Manual for Reservoir Regulation - Thames River Basin by the Corps of Engineers a Standard Project Flood of 96,000 CFS for local protection works in Norwich was developed for the Shetucket River with the storm centered over the uncontrolled drainage area downstream of the six flood control Corps of Engineers structures (Willimantic River Basin). The Test Flood (full P.M.F.) adopted for this Phase 1 Inspection Report is 141,500 CFS approximately 47% larger than the SPF and is assumed to be centered on the entire the 1261 sq. mile basin.

Test Flood should be redone including the impact of flood attenuation of the six Corps of Engineers reservoirs located upstream as detailed in Appendix F for a more detailed and realistic analysis.

The analysis indicates that the spillway capacity is not hydraulically adequate to pass the selected "test flood" (full PMF) for this dam and this flow would overtop the dam by approximately 6.2 feet. Overtopping of this dam has been computed assuming a uniform dam crest because the low point on the roadway at the left embankment is considered a temporary construction condition. The inflow and routed outflow discharge value for this test flood are 141,500 CFS and 140,000 CFS, respectively. The maximum outflow capacity of the spillway without overtopping the dam is 84,480 CFS which is 60.3 of the routed test flood outflow. Because of large flood control storage located upstream, a detailed analysis to determine the inflow at this dam is required to obtain a realistic magnitude and outflow and the overtopping potential.

5.5 Dam Failure Analysis. An instantaneous full depth-partial width breach of 200 feet was assumed to have occurred in the dam. This adopted breach width of 200 feet was based on visual inspection of

the downstream channel and topographic features. Assuming the river stage at the top of the dam just prior to failure the calculated dam failure discharge is equal to 131,720 CFS with outlet gates assumed closed.

This discharge will produce an approximate water surface level of elevation 28.3 feet immediately below the dam and will raise the water surface 3.0 feet above the level just prior to failure when the discharge is equal to 84,480 CFS. The reach of the river that will be impacted by this dam failure is that portion extending from the dam downstream to the Thames River. The failure discharge of 131,720 CFS may result in loss of more than a few lives, inundation of 20-25 dwellings and commercial properties in the City of Norwich, damage to the support structures for the 8th Street, Main St. (Rt. 2), Rt. 12, Water St. and Amtrack Railroad bridges and temporary disruption to traffic and utility services located within or along those roadways. Estimated depths of water from the dam failure discharge at those structures impacted by the failure could range from 1-3 feet. Riverbanks will sustain severe erosion and stripping and that the debris carried along by the failure wave can result in additional damage and flooding. Depths of flows downstream of the dam before and after failure are 18.0 and 21.0 feet for respective discharges of 84,480 and 131,720 CFS. In the vicinity of 11,000 feet downstream from this dam backwater effects from the Yantic and Thames River Basin will also affect the water surface elevations during high floods. As a result, the Greenville Dam has been classified as INTERMEDIATE in size but HIGH hazard structure.

## GREENVILLE DAM

Inflow, Outflow and Surcharge Data

FLOOD	24-HOUR TOTAL RAINFALL IN INCHES	24-HOUR* RUNOFF IN INCHES	MAXIMUM INFLOW IN CFS	MAXIMUM** OUTFLOW IN CFS	SURCHARGE HEIGHT IN FEET	SURCHARGI STORAGE ELEVATION
TEST FLOOD	21.4	19.0	141,500	140,000	22.20	42.5

\*Infiltration assumed as 0.1"/hour

\*\*Lake assumed initially full at spillway crest elevation 20.30  
(top of dam = 36.3)

NOTES:

1. "Test Flood" computation based on COE guidelines.
2. The maximum capacity of the spillway without overtopping the top of the dam elevation (36.30) is equal to 84,480 CFS.
3. All discharges indicated are dependent upon the continued integrity of upstream storage reservoirs.
4. Surcharge storage is assumed to overtop the dam when exceeding the spillway capacity.
5. Test flood = Full PMF = 112 CSM = 141,500 CFS (D.A. = 1261 sq. miles).
6. Spillway crest elevation adopted = 20.30.  
(Spillway crest elevation adopted in Master Manual of Reservoir Regulation - Thames River Basin = 21.40).

## SECTION 6

### EVALUATION OF STRUCTURAL STABILITY

- 6.1 Visual Observation. The visual observations did not disclose any immediate stability problems; however, a thorough visual inspection of the dam could not be made because of water flow over the spillway crest.
- 6.2 Design and Construction Data. Drawings are available showing the layout of the dam and the cross-section of the rockfilled timber crib. No other design and construction data are available.
- 6.3 Post-Construction Changes. The Greenville Dam was built in 1882. Records indicate that replacement of the timber planking started about 1947. Damage occurred to the planking during the intense storms of 1955 and additional repair work was apparently performed. Other recorded repair works has been performed in 1965, 1969, 1978 and at the present time, April 1980. Records indicate that all of the foregoing repairs were to the timber spillway only.
- 6.4 Seismic Stability. This dam is in located in Seismic Zone 1 and in accordance with the recommended Phase 1 guidelines, does not warrant seismic stability analysis.

## SECTION 7

### ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

#### 7.1 Dam Assessment

- a. Condition. Based on the observable portions of the Greenville Dam, the embankments and appurtenant structures are judged to be in FAIR condition. The condition of the timber crib spillway could not be evaluated due to the quantity of flow.
- b. Adequacy of Information. The visual inspection was not adequate for a complete Phase 1 level of investigation.
- c. Urgency. The recommendations and remedial measures described below should be implemented by the Owner within one year after receipt of this Phase 1 report.

#### 7.2 Recommendations

The following items should be accomplished under the supervision of a qualified registered engineer, experienced in the design of dams and any recommendations developed from the analysis should be implemented by the Owner.

1. Conduct further hydrologic and hydraulic studies to determine inflow, outflow and overtopping potential for this dam taking into account the impact of the six Corps of Engineers flood control structures located upstream.
2. Recommendations pertaining to the spillway portion of the dam will depend on further visual inspection of the dam. The dam should be inspected when the upstream water level is below crest elevation.
3. Investigate the seepage existing at the downstream toe adjacent to the left abutment of the dam and develop a methodology to measure and control the flow.
4. Repair the erosion area at the left abutment. Complete the work modification which is in progress at this location and restore the crest profile to its original grade.

#### 7.3 Remedial Measures

- a. Operation and Maintenance Procedures.
  1. Remedial measures pertaining to the spillway portion of the dam will depend on the results of further inspection of the dam.

2. Repair and restore to grade the construction roadway which has been cut in the left embankment. Grass should be planted on the restored surface.
3. Institute the technical inspection of the dam on an annual basis.
4. Develop and implement a regular maintenance program.
5. Develop an "Emergency Action Plan" that will include an effective pre-planned downstream warning systems. Items that should be identified in the plan should include the locations of emergency equipment, materials and manpower to reduce or minimize dam failure and/or overtopping, as well as, the authorities to contact including the Corps of Engineers. Potential downstream areas that would require evacuation should also be identified.
6. Implement a program of monitoring the dam during periods of flooding and other emergencies.
7. Cut the brush and weed growth from right embankment walls.

#### 7.4 Alternatives

There are no alternatives to the measures listed above.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST  
PARTY ORGANIZATION

PROJECT Greenville Dam DATE April 17, 1980

DATE April 17, 1980

WEATHER Fair

W.S. ELEV. 21.8 U.S. 9.2 D.S.

**PARTY:**

1. <u>R. Brown, CEM Civil</u>	6. <u>S. Khanna, CEM Hydraulics</u>
2. <u>E. Dessert, CEM Civil</u>	7. _____
3. <u>R. Murdock, GEI Geotechnical</u>	8. _____
4. <u>C. Rossoll, City of Norwich</u>	9. _____
5. <u>A. Nystrom, City of Norwich</u>	10. _____

## PROJECT FEATURE

INSPECTED BY

**REMARKS**

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

5. \_\_\_\_\_

6. \_\_\_\_\_

7. \_\_\_\_\_

8. \_\_\_\_\_

9. \_\_\_\_\_

10. \_\_\_\_\_

**PERIODIC INSPECTION CHECKLIST**

PROJECT	Greenville Dam	DATE	April 17, 1980
INSPECTOR		DISCIPLINE	
INSPECTOR		DISCIPLINE	
AREA EVALUATED	CONDITION		
<u>DAM EMBANKMENT</u>			
Crest Elevation	20.3		
Current Pool Elevation	21.8		
Maximum Impoundment to Date	Unknown		
Surface Cracks	None observed.		
Pavement Condition	Undulation along right side, left side covered with steel beams and concrete block.		
Movement or Settlement of Crest			
Lateral Movement	None observed.		
Vertical Alignment	Good		
Horizontal Alignment	Good		
Condition at Abutment and at Concrete Structures	Right abutment good. A road has been cut into the left abutment.		
Indications of Movement of Structural Items on Slopes	None observed.		
Trespassing on Slopes			
Sloughing or Erosion of Slopes or Abutments	Roadway and worn path on left side of dam. Erosion has occurred at the downstream toe.		
Rock Slope Protection	None		
Unusual Movement or Cracking at or Near Toe	None observed.		
Unusual Embankment or Downstream Seepage	Small seepage area observed along the downstream toe on left side of the dam		
Piping or Boils	None observed.		
Foundation Drainage Features	None		

## PERIODIC INSPECTION CHECKLIST

PROJECT Greenville Dam DATE April 17, 1980

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

AREA EVALUATED	CONDITION
<u>DAM EMBANKMENT</u> (Cont.)	
Toe Drains	None
Instrumentation System	None
Vegetation	Grass well maintained along crest on right side of dam.

**PERIODIC INSPECTION CHECKLIST**

PROJECT Greenville Dam DATE April 17, 1980

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	
a. Approach Channel	
Slope Conditions	Overgrown with trees and brush.
Bottom Conditions	Not observable.
Rock Slides or Falls	None
Log Boom	None
Debris	Not observable. Many overhanging trees.
b. Intake Structure	
Condition of Concrete and Stone Masonry	Good
Stop Logs and Slots	None

**PERIODIC INSPECTION CHECKLIST**

PROJECT Greenville Dam DATE April 17, 1980

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - CONTROL TOWER</u>	
a. Concrete and Structural	
General Condition	Timber superstructure. Mortared stone masonry foundation.
Condition of Joints	Timber - Fair Stone foundation - Good
Spalling	Good
Visible Reinforcing	Not observable.
Rusting or Staining of Concrete	Not observable.
Any Seepage or Efflorescence	Not observable.
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	Not observable.
Cracks	None observed.
Rusting or Corrosion of Steel	Stone masonry.
b. Mechanical and Electrical	
Crane Hoist	3 electrically operated gates and 3 manual gates, all of timber. Rack and pinion lift mechanism with timber stem.
Hydraulic System	None
Service Gates	None
Emergency Gates	Timber
Lightning Protection System	None
Emergency Power System	None

PERIODIC INSPECTION CHECKLIST

PROJECT Greenville Dam DATE April 17, 1980

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - TRANSITION AND CONDUIT</u>	Not observable.

**PERIODIC INSPECTION CHECKLIST**

PROJECT Greenville Dam DATE April 17, 1980

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u>	
General Condition of Concrete	Mortared stone masonry arch openings+
Spalling	None observed.
Erosion or Cavitation	None observed.
Any Seepage or Efflorescence	Not observable.
Condition at Joints	Good
Drain Holes	None observed.
Channel	
Loose Rock or Trees Overhanging Channel	Yes - trees.
Condition of Discharge Channel	Good

**PERIODIC INSPECTION CHECKLIST**

PROJECT Greenville Dam DATE April 17, 1980

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

INSPECTOR \_\_\_\_\_ DISCIPLINE \_\_\_\_\_

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	Shetucket River.
General Condition	Good
Loose Rock Overhanging Channel	None observed.
Trees Overhanging Channel	Yes
Floor of Approach Channel	Natural river bottom.
b. Training Walls	Mortared stone masonry.
General Condition of Stone Masonry	Good
Any Seepage or Efflorescence	Yes - see embankment checklist.
Drain Holes	None observed.
c. Weir	Stone masonry and timber. Not observable.
d. Discharge Channel	Natural bed of Shetucket River
Loose Rock Overhanging Channel	None observed.
Trees Overhanging Channel	Yes
Floor of Channel	Natural bottom.
Other Obstructions	None

APPENDIX B

ENGINEERING DATA

APPENDIX B-1

Correspondence pertaining to the history, maintenance, and modifications to the Greenville Dam as well as copies of past inspection reports are located at:

State of Connecticut  
Department of Environmental Protection  
State Office Building  
165 Capitol Avenue  
Hartford, Connecticut 06115  
Attention: Mr. Victor Galgowski,  
Dam Safety Engineer

APPENDIX B-2

SELECTED COPIES OF PAST INSPECTION REPORTS

CITY OF NORWICH  
DEPARTMENT OF PUBLIC UTILITIES  
DAM FAILURE CONTINGENCY PLAN

A. In the event of the failure or pending failure of the Greenville or Occum dams, the Watch Engineer at the North Main Street Power Station is to notify:

1. Norwich Police Department 889-1341 (Emergency)
2. Federal Energy Regulatory Commission (FERC) (212) 264-3687 (Office)

During non-office hours call:

Mr. James Hebson	(201) 998-2845
Mr. Martin Inwald	(516) 285-5964

3. Connecticut Light & Power 423-4561

B. The Norwich Police Department shall in turn immediately notify:

1. Norwich Fire Department 887-2521 (Emergency)
2. Norwich Public Works Department 887-5113 (Days)  
887-7300 (Nights)
3. Connecticut State Police 843-1201
4. Civil Defense Director,  
Miss Rita Frechette 887-1018 (Business)  
889-1417 (Residence)
5. Connecticut Department of  
Transportation 889-3301

C. The Connecticut Light & Power Company is to be requested to curtail the generation at their Scotland, Taftville (Ponemah), and Tunxis Hydro Stations to lessen the river flow.

BENJAMIN H. PALMER  
HEWARD B. PALMER

CHANDLER & PALMER  
CIVIL ENGINEERS  
114-116 THAYER BUILDING  
TELEPHONE TURNER 7-5640

DAMS  
WATER SUPPLIES  
SEWERAGE  
APPRAISALS  
REPORTS  
SURVEYS

MEMBERS AMERICAN AND CONNECTICUT SOCIETIES  
OF CIVIL ENGINEERS

NORWICH, CONN.

July 16, 1963

STATE WATER RESOURCES  
COMMISSION  
RECEIVED

JUL 17 1963

ANSWERED  
REFERRED  
FILED

Public Utilities Department  
34 Shetucket Street  
Norwich, Connecticut

Re: Greenville Dam

Gentlemen:

This afternoon I made an inspection of the Greenville Dam. This was located on the Shetucket River about a mile and a half North of the center of Norwich. The water on the pond was about one foot below full pond. The Contractor had removed about 15 of the planks on one section of the spillway. These planks had split and deteriorated. I noticed two small leaks coming through the dam, one about halfway across the dam, and the other one perhaps, 75 feet out from the West abutment. I recommend the following work to be done at once:

- a). Replace these planks that are split and broken.
- b). Fill in the back of the dam with good material from the bank on the East shore. This can be spread by means of a bulldozer and tractor and all of the holes in the embankment should be filled up about 20 feet from the spillway. I believe that this material, thoroughly compacted will stop the leaks that are visible at present. I think that this is all that needs to be done at this time.

The Easterly half of the lowest apron shows considerable wear on the ends of the oak planks. While I don't think there is any danger involved at present, I think you should plan to replace these planks next year. Apparently the ice and debris have worn the planks off. The dam, in general, is in pretty good shape, but since it is a timber dam, it requires considerable maintenance and a number of these planks have not been out for at least 15 years.

If the work is carried out as outlined above, I believe the dam will be safe.

Very truly yours,

CHANDLER & PALMER

B. H. Palmer

EHP/nir  
cc: State Water Resources Commission

January 31, 1969

Memo to: File

From: William H. O'Brien III

Subject: Greenville Dam - Norwich

The following is a summary of facts obtained from Mr. Albert F. Nystrom, Electrical Construction Superintendent for the Town of Norwich, Department of Public Utilities, owners of the dam, at a field inspection of the dam on January 15, 1959.

The present owners obtained the dam from the Norwich Water Power Company in 1961 or 62. Since that time, they have spent between \$80,000 and \$100,000 in repair work consisting primarily of replacement of rotted timbers downstream of the flashboards. Dry summers in the recent past had apparently accelerated deterioration from alternate wetting and drying. This work was done as it had been for the last 50 years by the Torrence Construction Co., Prospect Street, Norwich, John Vossler, owner. Practically all the exterior planking over which the water flows has been replaced. All wood used was native oak and work was done with the advice of Ben Palmer, Engineer, Norwich.

The following was carved into stone at the dam: "Built 1882 Hiram Cook, Pres & C. E., Directors: Frank Johnson, James D. Mowry, Charles P. Cogswell, Henry L. Parker"

The granite coping is in place as shown on cross section prints dated 1915, but there are now flashboards in place. There were 12 inch wide flashboards in place with reinforcing rods spaced 3½ feet apart for support. These rods were about 5 inches into the granite and 9" above with 2 x 3 braces for additional buttressing of boards at each support rod.

A set of plans was obtained from Mr. Nystrom for our records.

The dam appeared in very sound condition but it is recommended that the following work be done as part of routine maintenance.

1. Remove small maple tree on top of west earth abutment
2. Remove sapling growing from downstream face of west abutment
3. Remove trees on the east earth abutment
4. Replace some of horizontal planking at lowest level which has not yet been replaced. This is to be done as soon as they appear significantly weakened.

W.H.O. III  
Civil Engineer

W.H.O. III:vhb.

BENJAMIN H. PALMER  
SHEPARD S. PALMER

CHANDLER & PALMER  
CIVIL ENGINEERS  
114-116 THAYER BUILDING  
TELEPHONE 887-3640

DAMS  
WATER SUPPLIES  
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APPRaisALS  
REPORTS  
SURVEYS

MEMBERS AMERICAN AND CONNECTICUT SOCIETIES  
OF CIVIL ENGINEERS

NORWICH, CONN. 06360

December 4, 1969

Department of Public Utilities  
Shetucket Street  
Norwich, Connecticut

Attention: Mr. Robert E. Grimshaw

Dear Sir:

During the past month considerable repair work was done on the Greeneville Dam. This work was done by The Torrance Construction Company, and included a considerable amount of new planking on the middle apron and some planking on the slope.

During the work, a hole was discovered through the Dam which was allowing a considerable amount of leakage to come under the Dam and spill out below the lower apron. We put in various amounts of dye to try to trace this leak, and finally found the location. Generally speaking the location was about 161 feet west of the easterly abutment.

In this area new planking was put in on the upstream face of the Dam and 3 inch native oak planks were applied spiked to the timbers underneath. In some areas the timbers below were not in good condition. However, the planking was put on firmly and attached to the good areas. After the planking was put in the hole was again filled in and as far as we could tell, the leaks were substantially stopped. Mr. Nystrom of your Department has kept a careful record of the areas the planks were replaced or rebuilt.

I made several trips to the Dam during the construction period and believe the work was done satisfactorily and the Dam is in safe condition.

Very truly yours,

*B H Palmer*

Chandler & Palmer

BHP:mds



CITY OF NORWICH  
DEPARTMENT OF PUBLIC UTILITIES

P. O. BOX 1008  
34 SHETUCKET STREET  
NORWICH, CONN. 06360

December 27, 1978

Mr. Victor F. Galgowski  
Supt. of Dam Maintenance  
State of Connecticut  
Department of Environmental Protection  
State Office Building  
Hartford, Connecticut 06115

Re: Greenville Dam

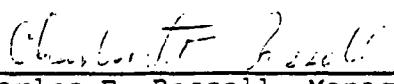
Dear Mr. Galgowski:

Enclosed is a copy of the specifications and the drawing that were used when the repairs to the Greenville Dam went out to bid. The work actually done was as follows:

- Item 1 (#1 on drawing) - replaced 113 sq. ft. of 3" plank
- Item 2 (#2 on drawing) - replaced 775 sq. ft. of 4" plank
- Item 3 (#5 on drawing) - replaced 1241 sq. ft. of 4" plank
- Item 4c (#6 on drawing) - replaced 190 sq. ft. of 4" plank
- Item 7 - replaced 100 linear feet of 8" x 12" timbers under surface - #5 on drawing.

We did not consider the work to be done as the type covered by Section 25-112 of the Connecticut General Statutes, so we did not apply for a permit.

Yours truly,

  
Charles F. Rossoll, Manager  
Electric Division

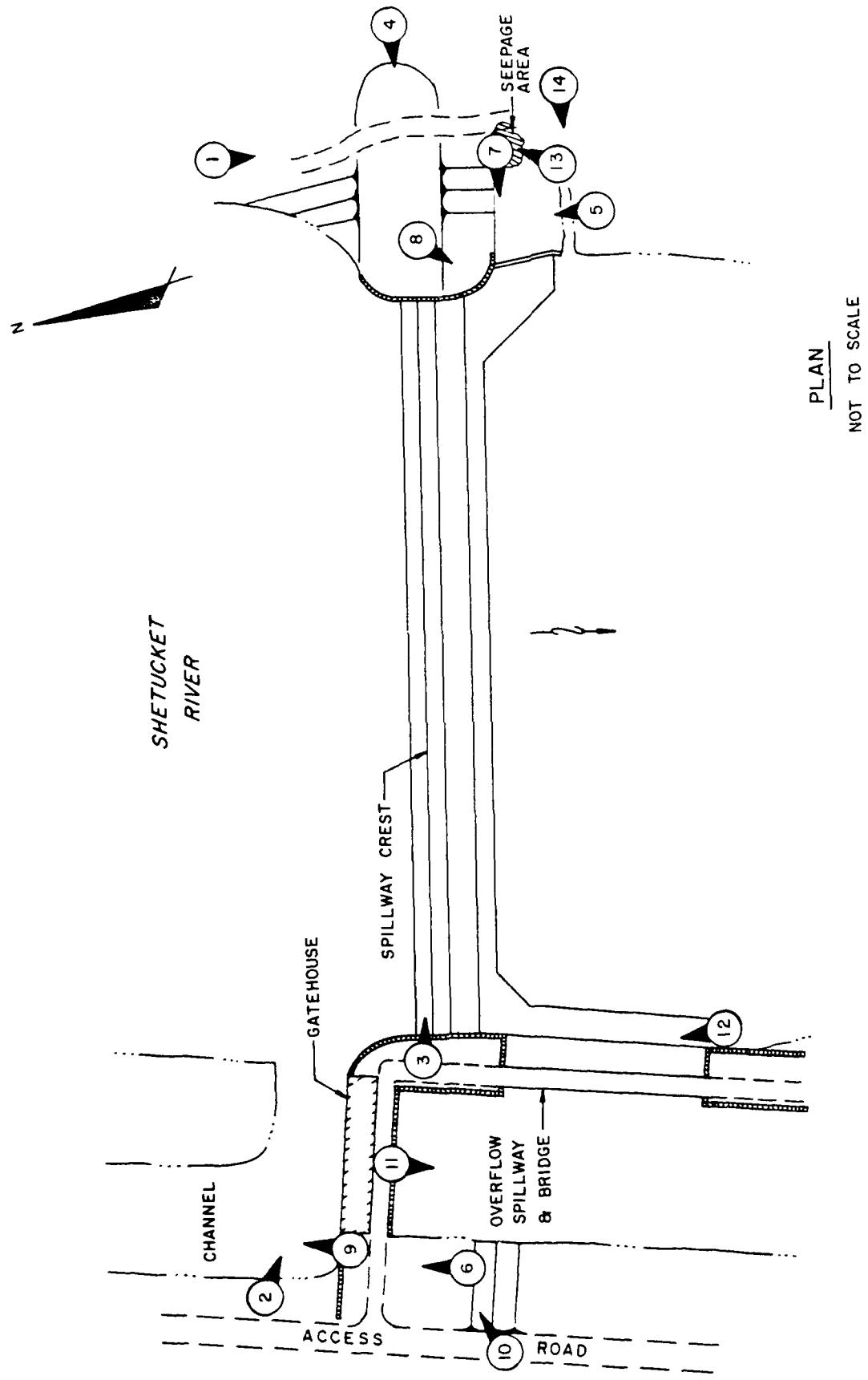
CFR/pas  
cc: Mr. A.F. Nystrom, Supt.  
Electric Production

ENCL.

APPENDIX B-3

PLANS, SECTIONS AND DETAILS

APPENDIX C  
PHOTOGRAPHS



GREENVILLE DAM  
PHOTO INDEX

PLAN  
NOT TO SCALE



PHOTO C-1 Upstream face of dam , left embankment.

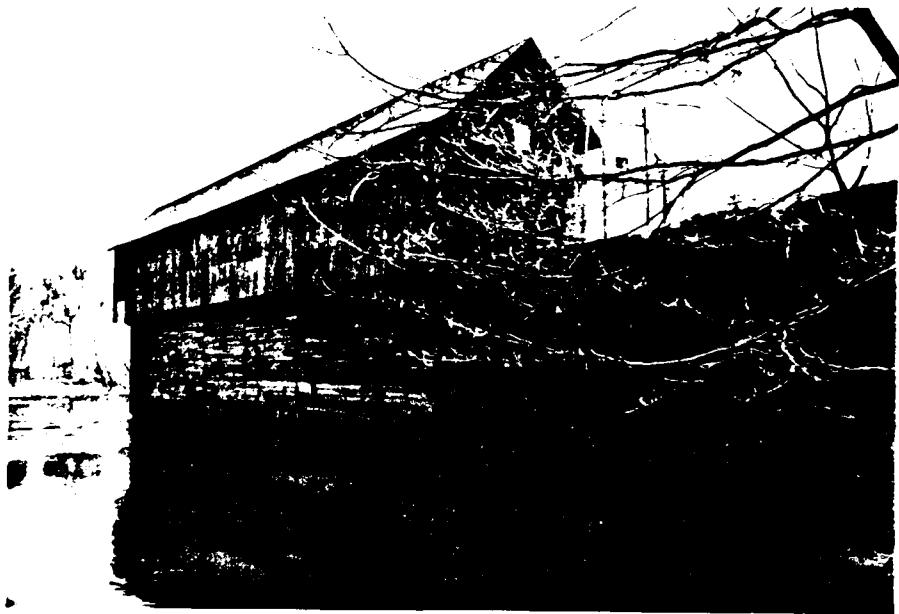


PHOTO C-2 Upstream face of dam, right embankment.

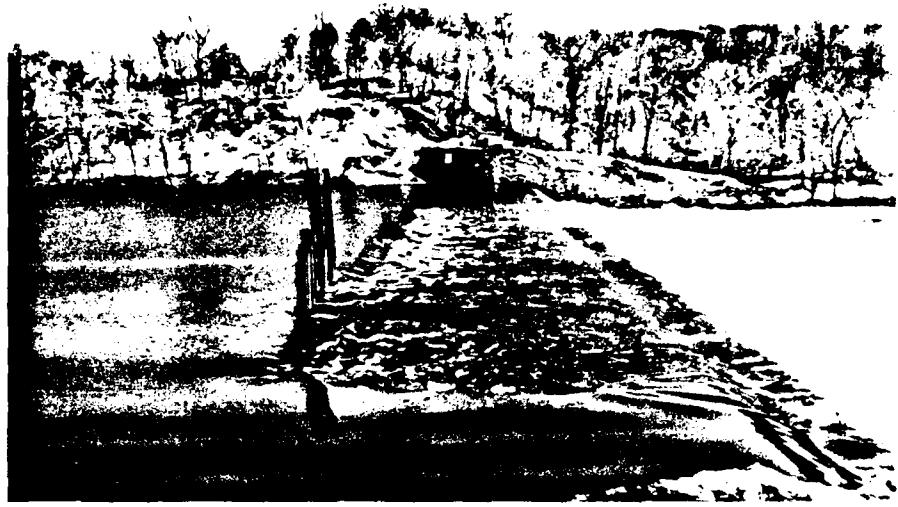


PHOTO C-3 Crest of spillway from right dam embankment.



PHOTO C-4 Crest of dam embankment, left side.



PHOTO C-5 Downstream face of embankment left side.



PHOTO C-6 Downstream face of dam (masonry) at right abutment,

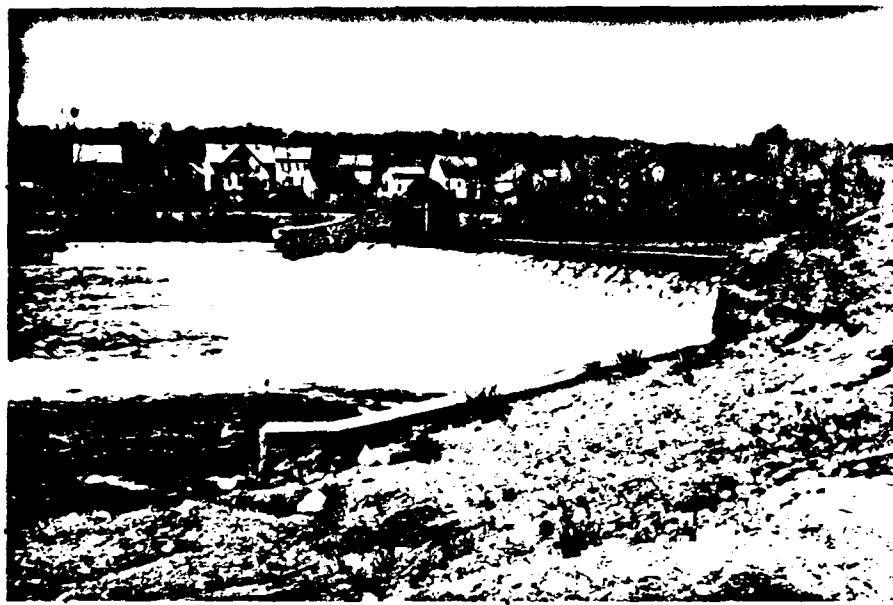


PHOTO C-7 Spillway from left side.



PHOTO C-8 Spillway discharge channel (Shetucket River)  
from left embankment.



PHOTO C-9 Intake channel.



PHOTO C-10 Outlet works.



PHOTO C-11 Outlet channel.



PHOTO C-12 Outlet channel spillway discharging to Shetucket River.



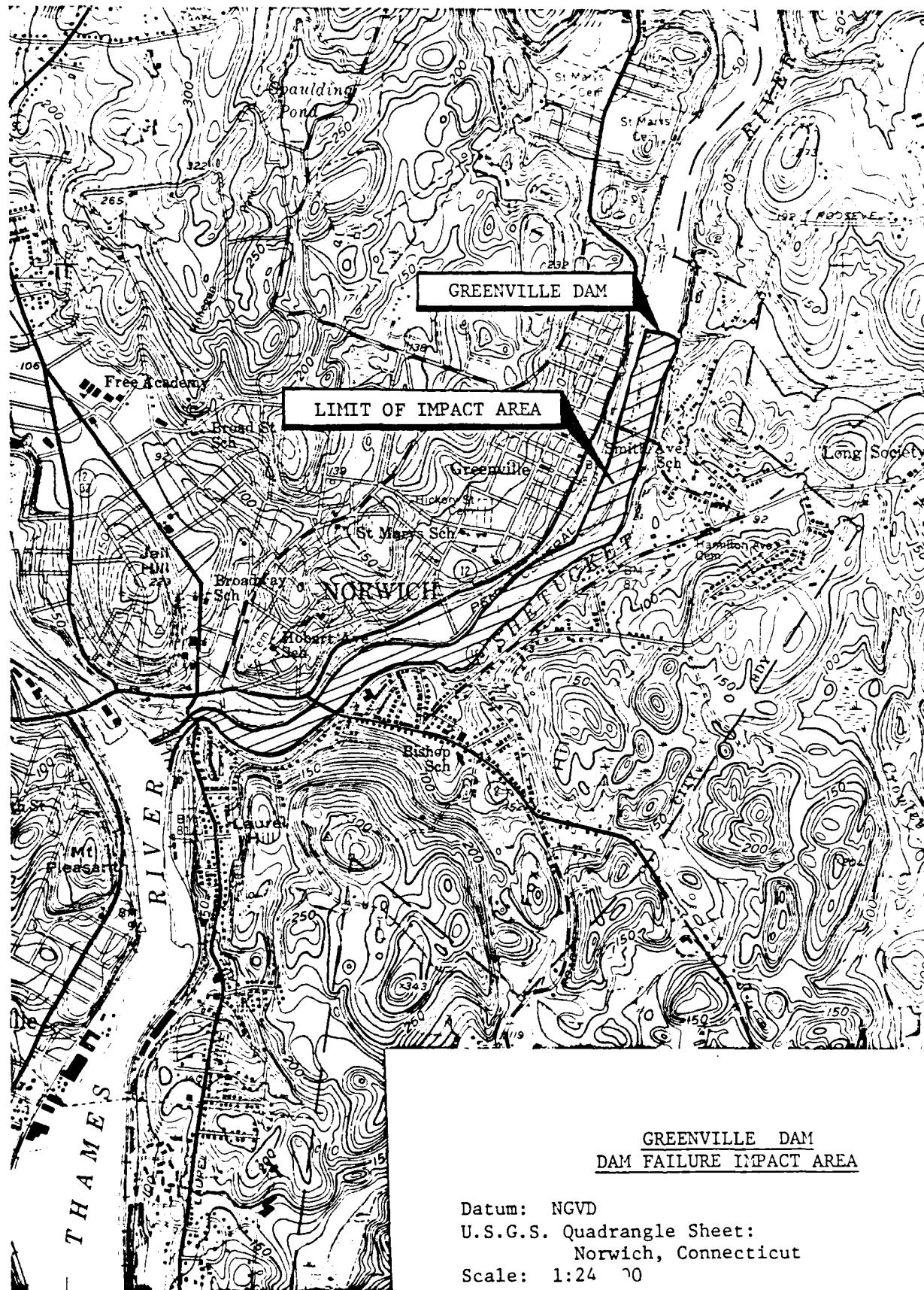
PHOTO C-13 Seepage area, left embankment.



PHOTO C-14 Erosion area downstream of left embankment.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



GREENVILLE DAM  
DAM FAILURE IMPACT AREA

Datum: NGVD  
U.S.G.S. Quadrangle Sheet:  
Norwich, Connecticut  
Scale: 1:24 70

A. Size Classification

Greenville Dam

Height of dam = 27.0 ft.; hence Small

Storage capacity at top of dam (elev. 36.30) = 3200 AC-FT.; hence Intermediate

Adopted size classification INTERMEDIATE

B. Hazard Potential

This dam is classified as a HIGH hazard potential structure because its failure could result in loss of many lives; damage and inundation of many dwellings and commercial properties in the City of Norwich; damage to the support structures for the 8th Street, Main Street (Rt. 2), Route 12, Water Street and Amtrack Railroad bridges; as well as temporary disruption of traffic and utility services located within or along these roadways. Loss of the dam will also prevent the generation of electricity by the City of Norwich.

C. Adopted Classifications

<u>HAZARD</u>	<u>SIZE</u>	<u>TEST FLOOD RANGE</u>
<u>HIGH</u>	<u>INTERMEDIATE</u>	<u>FULL PMF</u>
Adopted Test Flood =	Full PMF =	<u>112</u> csm
	=	<u>141,500</u> cfs

D. Overtopping Potential

Drainage Area =	<u>1261</u> sq. miles
Spillway crest elevation =	<u>20.30</u> ± NGVD
Top of Dam Elevation =	<u>36.30</u> ± NGVD
Maximum spillway discharge	
Capacity without overtopping of dam =	<u>84480</u> cfs
"test flood" inflow discharge =	<u>141,500</u> cfs
"test flood" outflow discharge =	<u>140,000</u> cfs
* of "test flood" overflow carried by spillway without overtopping =	<u>60.3</u>
"test flood" outflow discharge portion which overflows over the dam =	<u>55520</u>
* of test flood which overflows over the dam =	<u>39.7%</u>

## Estimating Maximum Probable Discharges - Inflow and Outflow Values

Date of Inspection: April 12, 1980Name of Dam Greenville Dam, Location of Dam Shehucket River, Town of Norwich, CTWatershed Characterization Rolling terrain; swampy; reservoirs; moderate to flat slopes. 126 sq. miles of drainage area is swampy or occupied by storage reservoirsAdopted "test" flood = Full PMP = 112 CFS = 141,500 cfs, Re = Effective rainfall = 19 inchesD.A. = Drainage Area (Gross) = 1261 Square Miles, Basin Slope = 0.004 hence, FlatS.A. = Surface Area of Reservoir = 0.25 Square Miles, Time of Concentration = more than one day  
(160 Acres)Shape and Type of Spillway = Free over flow crest weir; Timber cribbing with stone fillingB = Width of Spillway = 400 feet, C = Coefficient of Discharge = (3.33-Friction) = 3.30Maximum Capacity of Spillway Without Overtopping = 84480 CFS = 60.3 <sup>1</sup> of test floodTop of Dam Elevation = 36.3 ft, Spillway Crest Elevation = 20.3 ± (main soil/way)Overflow portion of Length of Dam = 664, C = Coefficient of discharge for Dam = 3.3

Name of Dam	Test Flood Q <sub>p</sub> CFS	Inflow Characteristics			Outflow Characteristics First Approximation			Outflow Characteristics Second Approximation			Outflow Characteristics Third Approximation (Adopted)		
		h <sub>0</sub> in feet	S <sub>0</sub> in in.	Q <sub>p1</sub> CFS	h <sub>1</sub> in ft.	S <sub>1</sub> in in.	Q <sub>p2</sub> CFS	h <sub>2</sub> in in.	S <sub>2</sub> in in.	Q <sub>p3</sub> CFS	h <sub>3</sub> in in.	S <sub>3</sub> in in.	Q <sub>p4</sub> CFS
1	112	141,500	23.00	0.06	—	—	—	—	—	—	—	22.2	140,000

Q<sub>p</sub> = Discharge, h = Surchage height, S = Storage in inches

Note: Outflow discharge values are computed as per COE guidelines.

NAME OF DAM: GREENVILLE DAM

ESTIMATING EFFECT OF SURCHARGE STORAGE ON "TEST FLOOD"

A. This routing of floods through the reservoir was carried out according to the guidelines established by the Corps of Engineers in Phase 1 Inspection for Dam Safety Investigations issued in March, 1978.

B. Formulas used are as follows:

1. For no overtopping:  $Q = C_1 B_1 h_1^{3/2}$   
 For overtopping:  $Q = C_1 B_1 [h_2 + F.B.]^{3/2} + C_2 B_2 h_2^{3/2}$   
 For open channel flow: N/A  
 For orifice flow: N/A

where  $C_1$  = coefficient of discharge for spillway;  $B_1$  = length of spillway  
 $C_2$  = coefficient of discharge for dam;  $B_2$  = length of dam  
 $h_1$  = head over spillway crest (feet);  $h_2$  = head over dam (feet)  
 $F.B.$  = distance between spillway crest and top of dam

- ii. Surcharge storage in inches =  $S = 12 (h_1 + h_2) \frac{S.A.}{D.A.}$  =  
 where S.A. = surface area =  
 D.A. = drainage area in sq. miles
- iii.  $Q_{outflow} = Q_{inflow} (1 - \frac{S}{R_e})$ ; where  $R_e$  = effective rainfall =
- iv. Length of dam = 400 ft. ; Top of Dam elev. = 36.3 ; c for dam = 3.3  
 Length of spillway = 400 ft. ; Spillway crest el. 20.3 ; c for spillway = 3.3  
 $Q = 3.3 \times 400 h^{1.5}$  where  $h$  is head over top of spillway crest  
 $S$  = storage in inches =  $12 h \frac{S.A.}{D.A.} = 0.0024 h$
- v.  $Q_{inflow} = 141,500 \text{ C.F.S.}$

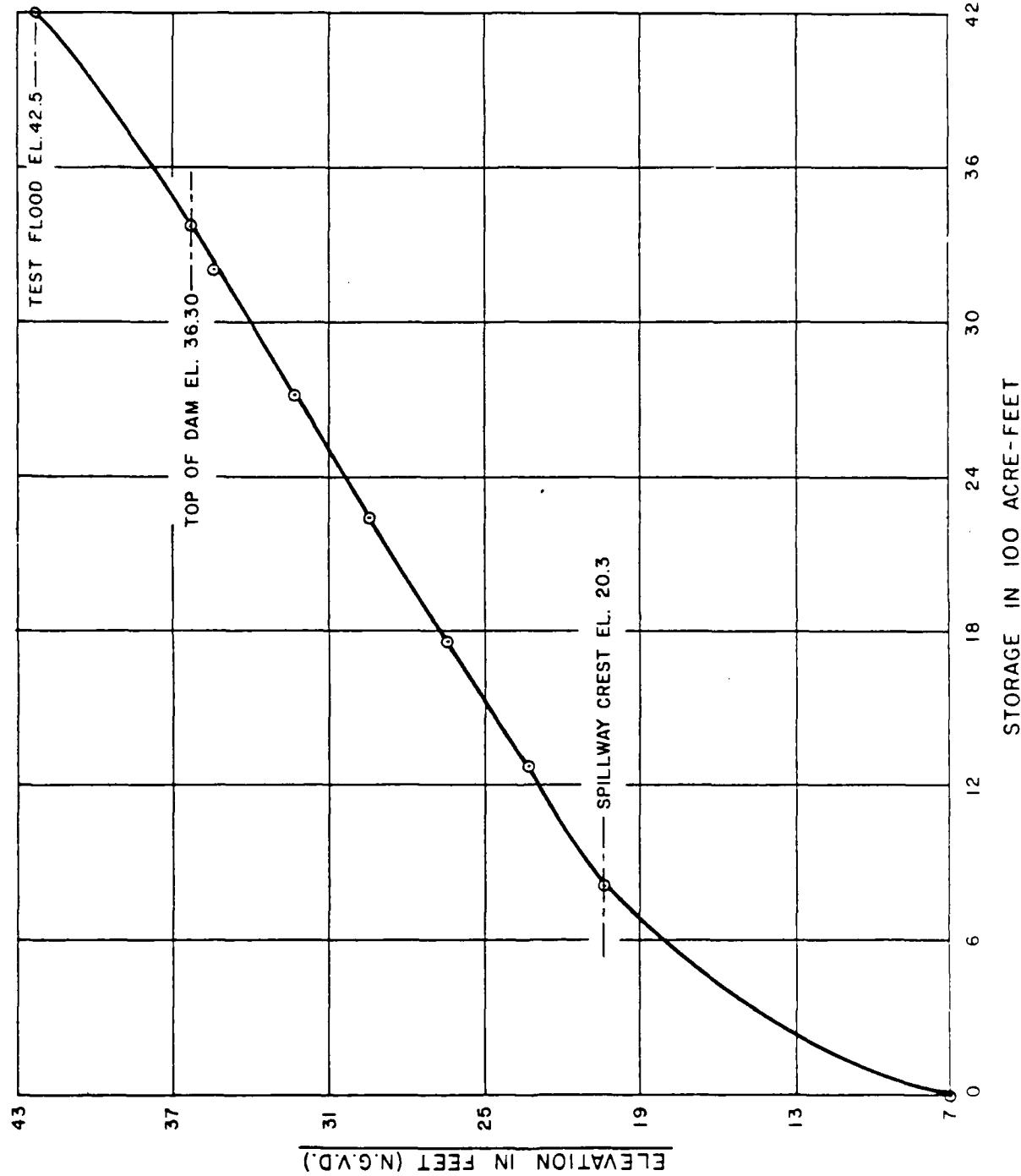
Q in CFS	Elevation	Total Head over crest $h_1 + h_2 = h$	Storage in inches = S	Remarks
141,284	32.3	12.0	0.029	
141,246	34.3	14.0	0.034	
141,217	36.3	16.0	0.038	
141,187	38.15	17.85	0.042	
141,179	38.3	18.0	0.043	
141,142	40.3	20.0	0.048	
141,097	42.5	22.2	0.054	

"Rule of Thumb Guidance for Estimating  
Downstream Dam Failure Discharge"

BASIC DATA

Name of dam Greenville Dam Name of town Norwich, CT  
Drainage area = 1261 sq. mi., Top of dam 36.3 ± NG  
Spillway type = Free overflow weir type Crest of spillway 20.3 ± NG  
Surface area at crest elevation = 160 Acres = 0.25 sq. mi.  
Reservoir bottom near dam = 7.3 NGVD  
Assumed side slopes of embankments 2:1  
Depth of reservoir at dam site 29.0 =  $y_0$  = 27.0 ±  
Mid-height elevation of dam = 23.0 NG  
Length of dam at crest = 400 ft.  
Length of dam at mid-height = 400 ft.  
50% of dam length at mid-height =  $w_b$  = 200 ft.  
Width of channel immediately downstream =  $B$  = 200 ft.; Shape of breach = rectangular

Elevation (NGVD)	Estimated Storage in AC-FT
20.30	800 Spillway Crest Elevation
23.30	1280
26.30	1760
29.30	2240
32.30	2720
35.30	3200
36.30	3360 Top of Dam Elevation
38.15	3656
42.50	4200 Test Flood Elevation



STORAGE-ELEVATION CURVE  
GREENVILLE DAM

## GREENVILLE DAM

### i. DAM FAILURE ANALYSIS

#### A. Failure Analysis

$$\text{Discharge} = \frac{8}{27} W_B \sqrt{g} y_o^{1.5}$$
$$= 1.68 W_B y_o^{1.5}$$
$$= 47140 \text{ C.F.S.}$$

C.F.S.

#### B. Maximum Spillway

Discharge with W.S.E.

At top of Dam @ 36.30 84480 C.F.S.

#### C. Total Dam Failure Discharge

131720 C.F.S.

#### D. Reservoir - Storage Data:

Volume of storage at spillway crest = 800 AC-ft. @ Elev. 20.30

Surcharge storage at top of dam = 2560 AC-ft. @ Elev. 36.30

Storage Total = 3360 AC-ft. @ Elev. 36.30

#### E. Flood Discharge Channel

i. Maximum depth of flow just D/S of Dam =  $\frac{4}{9} y_o = 12.0$  feet

#### Notes:

1. Failure of dam is assumed to be instantaneous. When pool reaches top of dam, and is a full-depth partial width rectangular shape failure with a width of failure =  $W = 200$  feet and depth of failure  $y_o = 27$  feet.
2. Steady, uniform flow phenomenon is assumed for determination of failure profile and is based on Manning's formulae.
3. Failure profile for impacted area determination is determined at one typical cross section in the downstream channel. Reduction in discharge due to available storage has been taken into account.

ii. Reach 1

Length = 11000 feet; Station 0 to Station 10+00;  $n = 0.05$

Bed slope =  $S_0 \approx S_f = 0.0017$ ; Bed width =  $b = 664$  feet

Bed width is scaled from U.S.G.S. map; scale 1" = 2,000 feet

As bed width is large and 1" = 2,000 feet and 10-foot contour interval scale maps are being used for various channel parameters, it is appropriate to assume that  $d = R$  = Hyd Radius = depth, hence Manning's formulae is transformed:

$$Q = A \frac{1.49}{n} R^{2/3} \quad \sqrt{S} = bd \frac{1.49}{n} d^{2/3} \quad \sqrt{S}$$

$$Q = b \frac{1.49}{n} \sqrt{S} d^{5/3} = K_d^{5/3} = 825 d^{5/3}$$

State Discharge Relationship for Reach 1

Depth = d in Feet	Stage of Elevation	Discharge in CFS = Q	Velocity in ft./sec.	Storage Volume in AC-ft. = V
0	6.3	0	0	0
2	8.3	2618	1.97	335
6	12.3	16325	4.09	1005
10	16.3	38234	5.76	1675
14	20.3	66973	7.20	2345
18	24.3	85085	8.52	3015
21	27.3	131604	9.43	3517

F. Water surface profiles resulting from maximum spillway discharge and also from dam failure discharge are shown on Plate D-13 for comparison purposes. This figure also shows the rise in water depth due to failure of dam.

Also, Discharge -- Depth and Storage-depth curves are shown on Plate D-14 for downstream channel.

Notes: 1. Storage volume in AC-ft =  $\frac{(\text{Length of Reach})(\text{Bed Width})(\text{Depth})}{43,560}$

2. Failure discharge being large will mostly be overbank flow on existing channel.

G. For  $Q_1 = 131720 \text{ CFS}$ ; depth = 21.0 ft.  $V_1 = 3517 \text{ AC-ft.}$

$$\text{Trial } Q_2 = Q_1 \left(1 - \frac{V_3}{\text{Storage}}\right) = \left(1 - \frac{3517}{3360}\right) = 0 \text{ CFS}$$

$$V_2 = 0 \text{ AC-ft.}$$

$$\text{Avg } V = \frac{V_1 + V_2}{2} = \text{AC-ft.}$$

$$Q_2 = Q_1 \left(1 - \frac{V \text{ Avg.}}{\text{Storage}}\right) = 62800 \text{ CFS}; y_2 = 13.5 \text{ ft.}$$

$$\text{Depth at center of flood as adopted} = \frac{21 + 13.5}{2} = 17.2 \text{ ft.}$$

Additional dam failure analysis beyond Reach 1 has not been undertaken because the depth of flow 17.2 feet at the end of Reach 1 will not cause any additional hazardous conditions further downstream. The failure discharge and depth will continually decrease beyond Reach 1. However almost total impacted area due to failure of dam is shown on Plate D-13. The depth of flow before failure of dam is 18.0 feet which is greater than 17.2 feet.

SUMMARIZED AND ADOPTED VALUES

FOR

DAM FAILURE ANALYSIS

- i. Name of Dam GREENVILLE DAM
- ii. Dam Failure Discharge \_\_\_\_\_ = 47140 cfs.
- iii. Maximum Spillway Discharge \_\_\_\_\_ = 84480 cfs.
- iv. Total Dam Failure Discharge \_\_\_\_\_ = 131720 cfs.
- v. Normal (Manning Depth) for 131720 = 21.0 feet
- vi. Normal (Manning Depth) for 84480 = 18.0 feet
- vii. Increase in depth due to failure of dam = 3.0 feet
- viii. W.S.E. prior to failure = Ground Elevation + 18.0
- ix. W.S.E. after failure = Ground Elevation + 21.0

Note: The adopted depth of flow values are assumed to be accurate representations of damages in the impacted areas. Professional judgement is used in these final adopted values.

Greenville Dam  
 COMPUTATIONS FOR  
 SPILLWAY RATING CURVE AND  
 CUTLET RATING CURVE COMPUTATIONS

Spillway width = 400 feet; Spillway crest elevation = 20.3 NGVD  
 Length of dam = 400 feet; Top of dam elevation = 36.3 NGVD  
 C = 3.3

ii) MAIN SPILLWAY RATING CURVE COMPUTATIONS

Elevation (ft.) NGVD	Spillway Discharge (CFS)	Remarks
20.30	0	Spillway Crest Elevation
23.30	5859	
26.30	19400	
29.30	35640	
32.30	54871	
35.30	76685	
36.30	84480	Top of Dam Elevation
38.15	100,000	
40.5	120,000	
42.5	140,000	Test Flood Elevation

ii) OUTLET RATING CURVE COMPUTATIONS

Elevation (ft.) NGVD	Discharge (CFS)	Remarks
9.30	0	Invert Elevation of Outlets
15.30	3000	
19.68	5958	Side Spillway Crest Elevation
20.30	7348	Main Spillway Crest Elevation
23.30	9000	
26.30	10392	
29.30	11619	
32.30	12728	
35.30	13748	
36.30	14071	Top of Dam Elevation
38.15	14651	
42.50	15600	Test Flood Elevation

Size of outlet = 6 - 10' x 10' (est.); Area of outlet = 600 sq. ft.

Invert of outlet = 9.30; Center line of outlet = 14.30

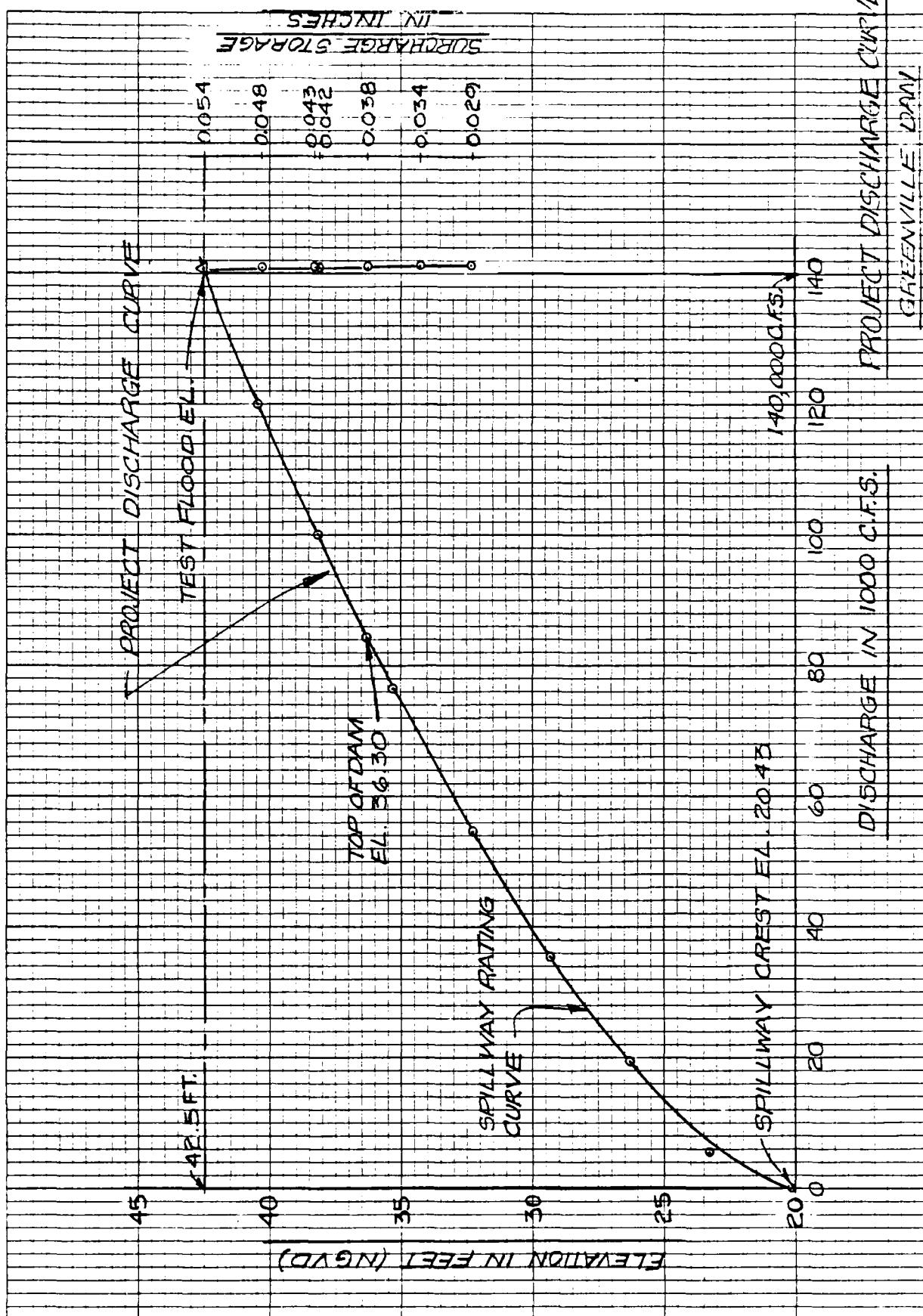


PLATE D-12



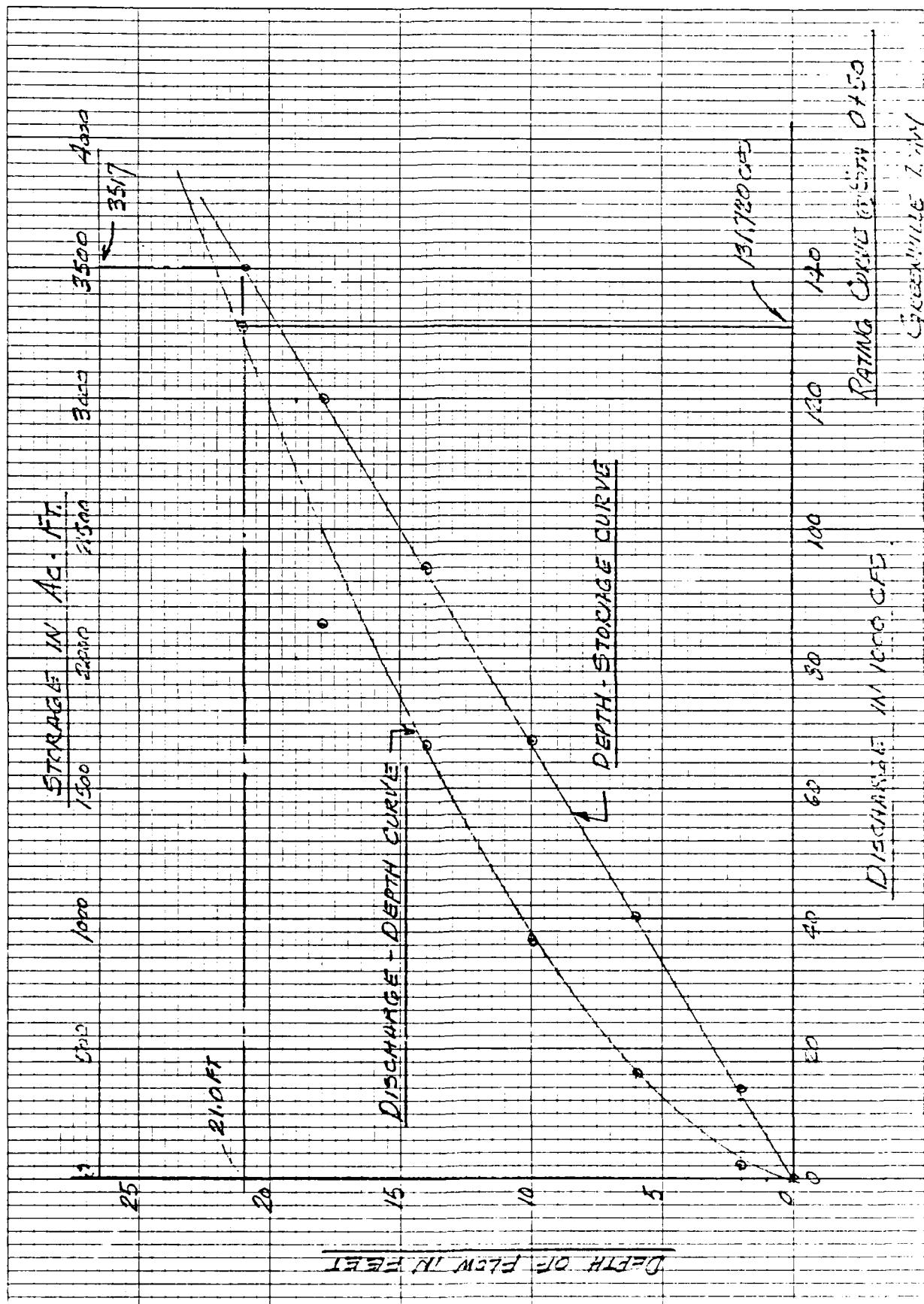
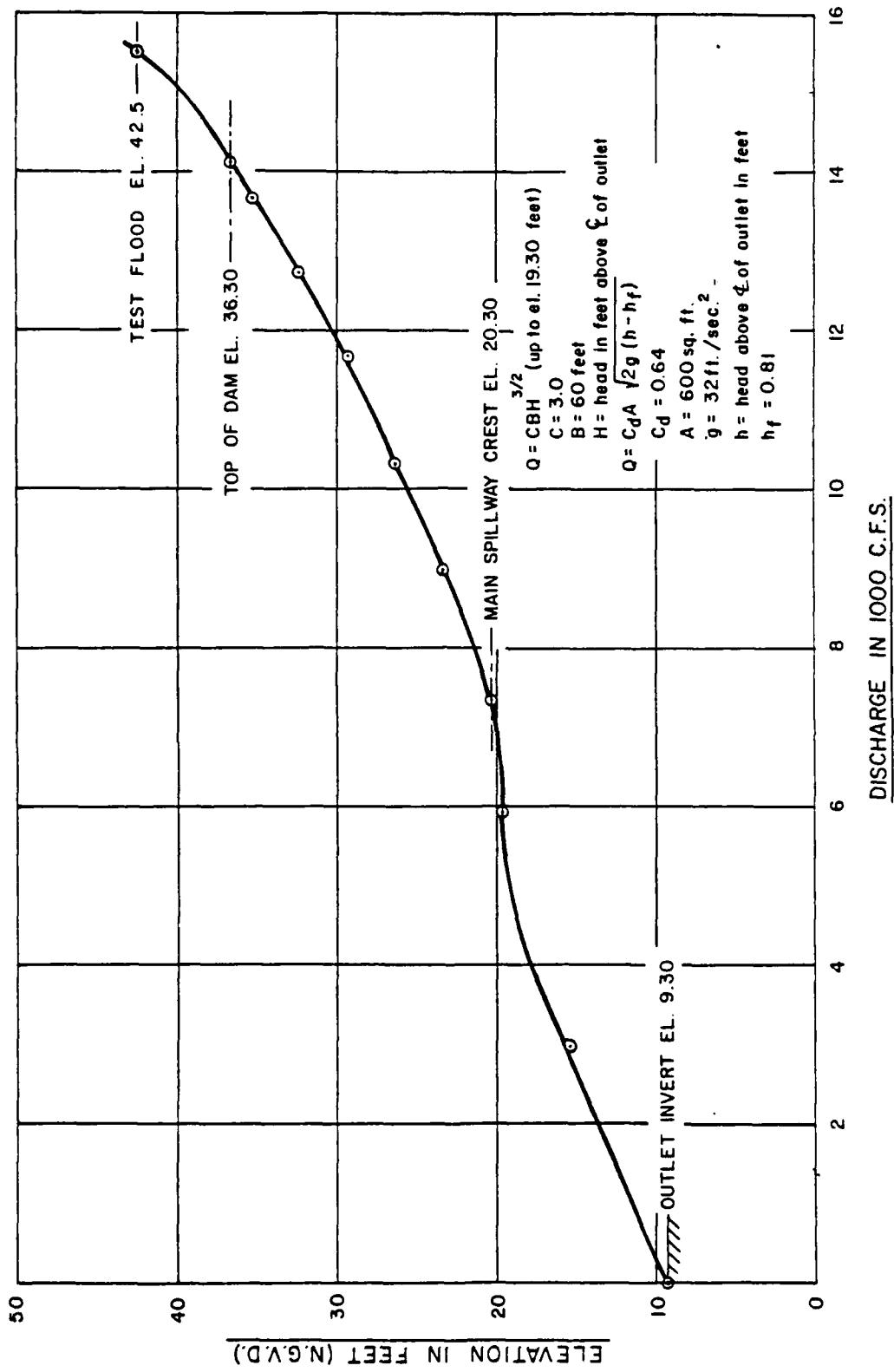


PLATE D - 14



OUTLET RATING CURVE  
GREENVILLE DAM

APPENDIX E

INFORMATION AS CONTAINED IN THE  
NATIONAL INVENTORY OF DAMS

# INVENTORY OF DAMS IN THE UNITED STATES

STATE/PROVINCE	COUNTY/STATE	CONC. COUNTY/STATE	CONC. COUNTY/STATE	CONC. COUNTY/STATE	CONC. COUNTY/STATE
CONN	NEW HAMPSHIRE	NEW JERSEY	NEW YORK	PENNSYLVANIA	VERMONT
CT	ME	NJ	NY	PA	VT
100	100	100	100	100	100

(1) POPULAR NAME		(2) NAME OF IMPOUNDMENT		(3) CONSTRUCTION DATE		(4) LATITUDE NORTH		(5) LONGITUDE (WEST)		(6) REPORT DATE DAY MO YR	
GREENVILLE DAM		SHETUCKET RIVER		1911-02		4132.3		7203.1			
(7) RIVER OR STREAM		(8) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE		(9) DIST. FROM DAM (MI.)		(10) POPULATION					
SHETUCKET RIVER		GREENVILLE		1		3000					
(11) TYPE OF DAM		(12) YEAR COMPLETED		(13) PURPOSES		(14) HYDRAULIC HEIGHT (FT.)		(15) IMPOUNDING CAPACITIES (ACRE-FT.)		(16) DIST. OWN FED. R. PRIV/FED. SCS A. VER/DATE	
PCC		1882		H		29		27		3360 800 NED N N N N N N	
(17) REMARKS											
PLANKED CRIB STONE FILLED 23-WATER STORAGE FOR GAS PLANT											
(18) U.S. SPILLWAY HAS LENGTH (FT.)		(19) MAXIMUM VOLUME OF DAM (CY)		(20) POWER CAPACITY INSTALLED (KWH)		(21) NAVIGATION LOCKS					
1 604		1 400		8480		NO		NO			
(22) CITY OF DESIGN CONSTRUCTION		(23) ENGINEERING BY		(24) CONSTRUCTION BY							
NEW HAMPSHIRE		C. C. ER		C. C. ER							
(25) REGULATORY AGENCY		(26) OPERATION		(27) MAINTENANCE							
CE MAGUIRE INC		07 APR 80		PL 92-367							
(28) REMARKS											
(29) INSPECTION BY		(30) INSPECTION DATE		(31) AUTHORITY FOR INSPECTION							

APPENDIX F

PERTINENT DATA FROM THE MASTER MANUAL OF RESERVOIR  
REGULATIONS - THAMES RIVER BASIN, CONNECTICUT

recession side of the main Quinebaug River hydrograph. The studies also indicated that the local areas immediately above the damage centers in the Quinebaug basin are the prime contributors to the peak flows

### 31. STANDARD PROJECT FLOODS

Examination of the records of great storms in the Thames River basin and adjacent watersheds indicates that somewhat greater floods than those previously experienced may be expected to occur in the future, therefore, standard project floods were developed to be used as a guide in determining flood control requirements in the basin. Due to geographical distribution of the damage centers, two standard project floods were developed, one with the storm centered over the upper Quinebaug River basin and the second, with the storm centered over the Willimantic River. Standard project storm rainfall was determined as described in Civil Engineer Bulletin 52-8. Standard project flood hydrographs were determined by means of unit hydrographs and flood routings. Standard project flood peak discharges for selected points within the Thames River basin are shown in table 7 and on plates 16 and 18.

TABLE 7

#### STANDARD PROJECT FLOODS THAMES RIVER BASIN

<u>Location</u>	<u>River</u>	<u>Drainage Area (sq.mi.)</u>	<u>Peak Discharge (cfs)</u>
South Coventry	Willimantic	121	38,000*
Willimantic	Natchaug	169	28,700*
Willimantic	Shetucket	401	80,300*
Norwich	Shetucket	1,260	129,000* ~
Webster	French	85	16,300**
Southbridge	Quinebaug	126	28,500**
Putnam	Quinebaug	331	55,000**
Jewett City	Quinebaug	711	61,500**

\* Storm centered over Willimantic River basin  
\*\* Storm centered over Quinebaug River basin

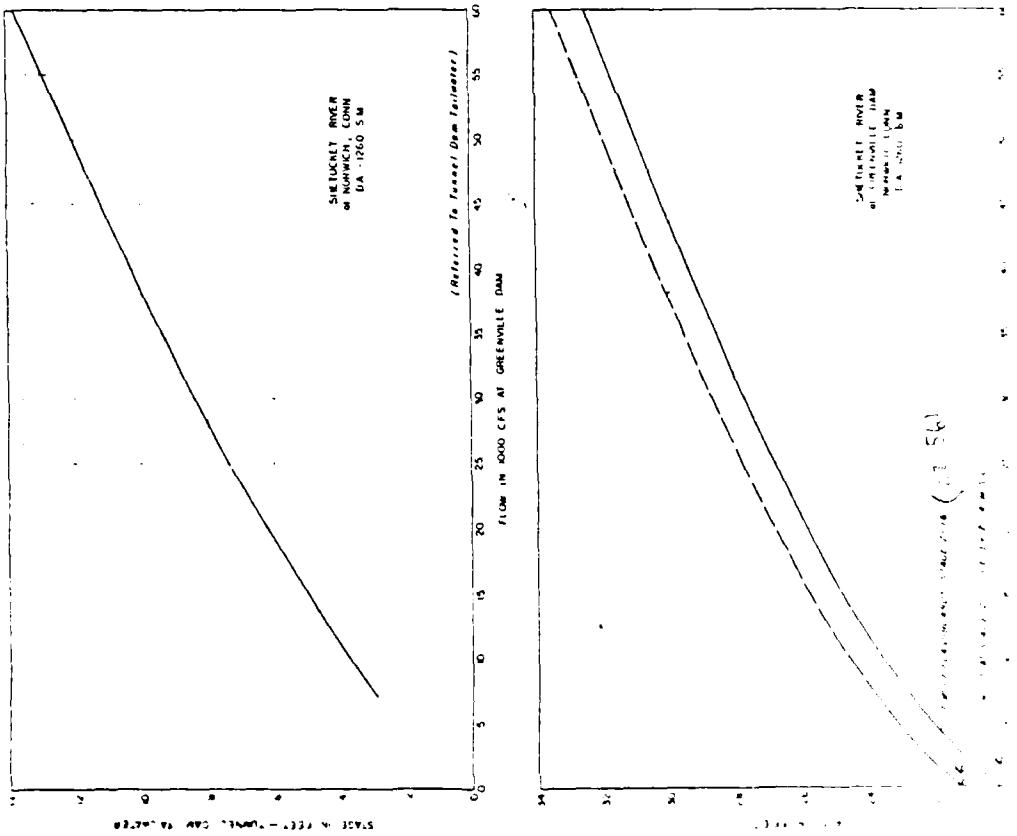
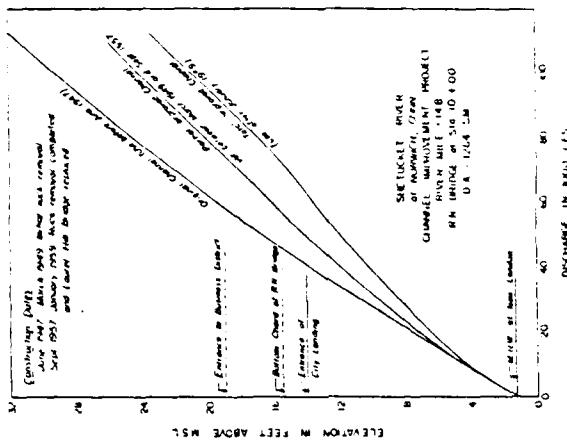


TABLE 8  
 THAMES RIVER BASIN  
 CORPS OF ENGINEERS  
 COMPREHENSIVE FLOOD CONTROL PLAN

<u>Reservoirs</u>	<u>River</u>	<u>State</u>	<u>Drainage Area (sq.mi.)</u>	<u>Flood Control Storage (acre-feet)</u>	<u>Status</u>
Hodges Village	French	Mass.	31	13,250	1959*
Burrville	Little	Mass.	26.5	11,300	1958*
East Brimfield	Quinebaug	Mass.	67.5	29,900	1960*
Westville	Quinebaug	Mass.	32**	11,000	1962*
West Thompson	Quinebaug	Conn.	74**	25,600	1965*
Mansfield Hollow	Watauga	Conn.	159	49,200	1952*
Andover	Hop	Conn.	52	16,800	Inactive
South Coventry	Willimantic	Conn.	114	36,900	Inactive
<u>Local Protection Project</u>					
Norwich	Shetucket	Conn.	1260	-	1959*

\* Year completed  
 \*\* Net drainage area

TABLE 9  
EFFECT OF FLOOD CONTROL RESERVOIRS AT DAMAGE CENTERS

River	Damage Center	Low Water Stage (ft)	March 1936 Flood				September 1938 Flood			
			Natural Stage (ft)	Natural Flow (cfs)	Modified Stage (ft)	Modified Flow (cfs)	Natural Stage (ft)	Natural Flow (cfs)	Modified Stage (ft)	Modified Flow (cfs)
Quinebaug	Southbridge, Mass. American Optical Company Dam Headwater	0.0	4.8	6,500	2.6	3,400	6.8	13,000	2.6	3,400
Quinebaug	Putnam, Conn. USGS Gage	2.0	17.5	17,000	10.9	6,500	19.5	20,900	10.2	5,600
Quinebaug	Jevett City, Conn. USGS Gage	4.0	24.0	29,200	21.8	22,900	21.7	22,800	15.7	11,700
French	Webster, Mass. USGS Gage	4.5	15.9	4,700	9.7	1,500	12.4	2,800	8.8	1,200
Shetucket	Willimantic, Conn. USGS Gage	2.0	18.4	23,900	13.5	12,900	27.6	52,200	19.1	25,700
Shetucket	Norwich, Conn. Greenville Dam Headwater	20.0	30.6	51,500	29.0	37,200	33.6	75,000	30.6	47,200

River	Damage Center	Low Water Stage (ft)	August 1955 Flood				Standard Project Flood			
			Natural Stage (ft)	Natural Flow (cfs)	Modified Stage (ft)	Modified Flow (cfs)	Natural Stage (ft)	Natural Flow (cfs)	Modified Stage (ft)	Modified Flow (cfs)
Quinebaug	Southbridge, Mass. American Optical Company Dam Headwater	0.0	11.4* 8.4**	36,000* 20,400**	8.1* 3.3**	24,500* 8,000**	10.2	28,500	3.0	9,600
Quinebaug	Putnam, Conn. USGS Gage	2.0	26.5* 25.6**	48,000* 43,800**	16.0* 14.8**	14,100* 12,000**	27.5	55,000	18.6	19,300
Quinebaug	Jevett City, Conn. USGS Gage	4.0	29.0	40,700	19.9	17,500	35.5	61,500	28.6	39,500
French	Webster, Mass. USGS Gage	4.5	26.0	14,000	16.2	4,900	27.5	16,300	19.5	7,600
Shetucket	Willimantic, Conn. USGS Gage	2.0	21.7	33,200	17.4	21,300	35.7	80,300	28.0	53,600
Shetucket	Norwich, Conn. Greenville Dam Headwater	20.0	33.6	65,000	29.6	35,200	40.6	129,000	36.9	94,000

\* Includes dam failure on Cady Brook  
\*\* Assumes no dam failure on Cady Brook

NOTE: Reservoir system includes: Mansfield Hollow,  
Buffumville, Hodges Village, East Brimfield,  
Westville and West Thompson

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